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Seeds, fruits and nuts in the Scottish Mesolithic

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ABSTRACT

Over the past few decades, the potential importance of plants within European Mesolithic economies has frequently been discussed, but there has been little systematic consideration of the archaeobotanical evidence for Mesolithic plant consumption in Scotland. This paper assesses the use of plants in the Scottish Mesolithic economy using the archaeobotanical evidence from 48 sites. It is argued that plants were systematically, and, in some cases, intensively exploited in Mesolithic Scotland. Though plant remains were extremely sparse at most sites, it is suggested that uneven archaeological sampling and taphonomic factors, together with the relatively short duration of occupation of many sites, may be responsible for the restricted range and frequency of edible taxa in most assemblages.

INTRODUCTION

European Mesolithic 'hunter-gatherers' have often been perceived primarily as hunters rather than gatherers (eg Jarman 1972; Price 1987: 288). Processual approaches in Mesolithic subsistence studies have concentrated on the ranking of 'staple' resources, and there has been an over-emphasis on the species that have been considered to be of most calorific importance, such as red deer and marine foods, at the expense of foodstuffs thought to be of relatively minor significance, such as wild plants (Finlay 2000; Milner 2009: 71). This is in spite of the fact that plants are widely acknowledged to play a crucial physiological and nutritional role within the human diet (eg Speth 1989; King 1994: 196; Zvelebil 1994: 58; Vaughan & Geissler 1997: 200) and that abundant evidence exists for the importance of plants within many past and present hunter-gatherer economies (Kuhnlein & Turner 1991: 10; Moerman 1998: 15; Crowe 2005: 8–9; Anderson 2006: 242; Rowley-Conwy & Layton 2011: 855).

Though some have argued for the importance of plants within European Mesolithic subsistence strategies (Clarke 1976; Mellars 1976a: 30; 1976b; Mason et al 1994; Zvelebil 1994; Mithen et al 2001; McComb 2009; Holst 2010), and there has been discussion about the potential role of Mesolithic communities in the management of wild plant resources (Harris 1989; Zvelebil 1994; Warren et al 2014), little systematic archaeobotanical research has been undertaken to substantiate these suggestions. This is largely a consequence of the widespread assumption that plant remains are rarely preserved in the Mesolithic, and as a result, detailed environmental sampling and analysis has not been routinely undertaken on Mesolithic sites (Mason et al 1994: 54; Hather & Mason 2002: 2). In fact, where appropriate methods have been employed, diverse assemblages of plant remains have frequently been recovered (Hather & Mason 2002: 2; Mason et al 2002: 195).

Instead, research has focused on stone tools – the most frequently preserved finds on

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Mesolithic sites – which have primarily been viewed as meat and fish hunting/processing tools rather than plant processing implements (Clarke 1976: 452; Finlayson & Edwards 2003: 122; Warren 2005: 86). This is contrary to recent use-wear and artefact residue analysis results, which have shown that many Mesolithic stone tools were used for multiple purposes, including wood and plant processing (Grace 1992: 62; Finlayson 2004: 224–5; Hardy 2004: 44; Hardy & Shiel 2007; Milner 2009: 66).

In Scotland, this situation has been compounded by the nature of the history of research. Since most Mesolithic sites identified on the east coast of Scotland consist of unexcavated lithic scatters (Finlayson 2004: 222), evidence for the use of edible plants has rarely been recovered, reinforcing the view that meat was the primary foodstuff consumed. Moreover, research-driven excavation projects in Scotland have focused on west coast shell midden sites rather than on terrestrial sites, because of the excellent organic preservation in shell middens and the difficulty of locating inland sites (Wickham-Jones 2004b: 2; 2009: 478). Arguably this has further skewed perceptions of the Mesolithic diet. Since shell middens are specialised sites involving marine exploitation (Wickham-Jones 2009: 481), it is perhaps unsurprising that plant remains are relatively less abundant in such contexts compared to marine resources. Also, many shell middens were excavated in the 19th or early 20th century, before the development of modern sampling procedures (Wickham-Jones 2004b: 5), and so no plant remains have been recovered from these sites. Equally, the plant remains recovered from modern excavations of Scottish shell middens have rarely been studied in detail, with research focusing almost exclusively on animal resources (eg Mellars 1978; 1987). Consequently, the true significance of plants in such contexts remains uncertain. Furthermore, shell middens are often highly visible, easy to access and are easily identified as a result of coastal erosion. In contrast, inland sites are much harder to find due to large areas of land being covered in blanket bog, moors and mountains and the probable destruction of lowland Mesolithic sites as a result of development (Wickham-Jones 2004b: 2). Therefore, though a number of shell middens have been excavated, they form only a very minor proportion of Mesolithic sites in Scotland (Wickham-Jones 2009: 478–9) and arguably the contents of middens cannot be regarded as typical of the overall Mesolithic diet.

The marine-orientated view of the Mesolithic economy has been further emphasised by recent isotopic analyses of the human bone from the Oronsay shell middens, which have produced highly marine signatures (Richards & Mellars 1998; Schulting & Richards 2000; 2002). However, due to the current uncertainties of the marine reservoir correction that should be applied to dates of this period from individuals with marine-dominated diets, the calibrated dates from these bones have fluctuated across the Mesolithic–Neolithic transition in different publications (Richards & Sheridan 2000; Schulting & Richards 2002; Milner & Craig 2009). Consequently, it is possible that several of the radiocarbon dates are contemporary with dates from the earliest Neolithic period (Schulting & Richards 2002). Even if these human bones are accepted to be 'Mesolithic', arguably their isotopic signatures are not representative of the overall Mesolithic economy. Since only four dated human bones from two of the Oronsay shell middens have been analysed, they may represent groups of coastal hunter-gatherers with more marine-orientated diets than inland communities (Milner et al 2003; Milner 2009: 66). Indeed, isotopic analyses on Mesolithic human bones from elsewhere in Britain and Ireland have produced a much more varied picture, with some individuals with a predominantly terrestrial diet, some with a more marine-orientated diet and others with mixed diets (Schulting & Richards 2000; Richards et al 2003; Milner 2009: 66).

Moreover, palynological evidence highlights the potential importance of plants within the

Scottish Mesolithic. There is an extensive body of pollen evidence for small-scale, human-woodland manipulation in Mesolithic Scotland (eg Bohncke 1988; Edwards 1996a; 2000; 2004; 2009; Edwards & Ralston 1984; Edwards & Sugden 2003; Hirons & Edwards 1990; Tipping 1995a; b), which may provide support for the active role of hunter-gatherers in managing wild plants. Thus, the role of plants within Scottish Mesolithic subsistence strategies requires reassessment.

This review seeks to assess the evidence for the importance of plants within Scottish Mesolithic subsistence strategies, using the archaeobotanical data from 48 Scottish Mesolithic sites, together with ethnobotanic evidence for wild plant gathering. The following research questions will be addressed in this paper:

- What evidence is there for the gathering, processing and cooking of wild plants in the Scottish Mesolithic?
- Is there any evidence that plant use was large-scale and intensive in the Scottish Mesolithic?
- Could hazelnuts have been used as a staple food in the Scottish Mesolithic?
- What is the future potential of the Scottish archaeobotanical resource for studying Mesolithic plant exploitation?

METHODOLOGY

DATA SELECTION

Following the methodology of Bishop et al (2009), a database of 48 Mesolithic sites with archaeobotanical remains was compiled (Table 1) by systematically searching through regional and national journals, major monograph series and excavation reports produced after 1960. Site references were also obtained from previous reviews of plant macrofossils and Mesolithic radiocarbon dates (Dickson & Dickson 2000; Ashmore 2004b) and unpublished data from several sites was obtained from archaeological units and academics researching Mesolithic Scotland (see Acknowledgments). In addition, sites with Mesolithic radiocarbon dates from *Discovery and Excavation in Scotland* 1970–2010 were also investigated further where possible. However, some of these sites were either still in the initial stages of the post-excavation process or had not yet been fully published. Therefore, the review is a comprehensive, but not a complete list of all Mesolithic sites with plant remains in Scotland.

Sites were included in the review if they met the following criteria. All Mesolithic sites where the remains of charred nuts, fruits, roots/tubers/parenchyma or seeds have been recovered by hand-collection or sampling were included in the database. In addition, sampled sites where wood charcoal was the only plant component recovered were included in the database of sites (Table 1), since it was considered that edible plant remains should have been recovered from these sites if they had been present. These sites are only included in this paper with regards to the total number of site blocks (see next section for definition of a 'site block') and they are not listed in results Tables 3–6. The charcoal from these sites, together with the charcoal from the other sites in Table 1, will form the subject of a future paper on wood procurement and management strategies. While it would have been preferable to only include sites where sampling was undertaken to ensure the data was representative of the plant remains present on site (van der Veen 1984: 193; Jones 2000: 79), this would have severely restricted the number of sites available for synthesis because sampling on Mesolithic sites has not been systematically undertaken. Plant remains from natural soil profiles were excluded from the database.

Plant remains were considered to be Mesolithic in date if they were from secure contexts and were either directly radiocarbon dated or associated with material radiocarbon dated to within accepted chronological ranges for the Mesolithic period in Scotland, *c* 8600–4000 cal BC (Ashmore 2004a; 2004b), or if they

Table 1
Description of each site in the review. For a description of the woodland zone classifications see Methodology section. LMI: later Mesolithic I; LMII: later Mesolithic II; M: Mesolithic. The locations of the sites are shown in illus 1. The bold text in the Site description column indicates the contexts of recovery of the plant remains

Site	*Site number*	*Woodland zone*	*Site period*	*Period block*	*Site description*	*Sampling information*	*References*
Ailsa View	1	2	mid 8th–early 7th millennium cal BC	LMI	**possible hearth pits**, **pits** and a lithic scatter	judgement sampling, bulk samples, flotation	Cook & Engl 2002; Gooder 2002, 2004; Gooder & Engl 2002; Miller 2002
Aird Calanais	2	3	early 6th–mid 5th millennium cal BC	LMII	**old ground surface**	total sampling, bulk samples, flotation	Flitcroft & Heald 1997; O'Brien et al 2009
Auchareoch	3	1	late 8th–late 7th millennium cal BC	LMI	lithic scatter, **fire spots** and a **pit**	no information available	Affleck et al 1988
Beattock	4	2	late 7th–early 6th millennium cal BC	LMII	**a pit**	total sampling, bulk samples, sieving	Dunbar 2008
Biggar Common	5	2	mid 6th–early 5th millennium cal BC	LMII	**stake-holes**, post-holes, charcoal spread and shallow hollow (stake-built structure)	judgement sampling, bulk samples, no further information available	Crone 1997; Johnston 1997
Camas Daraich	6	1	late 8th–late 7th millennium cal BC	LMI	occupation layers, **scoops** and a **possible hearth**	bulk samples, no further information available	Cressey 2004; Wickham-Jones et al 2004
Carn Southern	7	1	associated with Mesolithic artefacts	M	flint scatters, **occupation layer**, but no hearths or structures	wet sieving of most deposits, no further information available	Searight 1990
Castle Street	8	1	late 8th–early 6th millennium cal BC	M	**occupation layers** containing artefacts and ecofacts and incorporating a possible hearth	soil wet sieved to 5mm, no further information available	Dickson 1985; Wordsworth et al 1985

Site	*Site number*	*Woodland zone*	*Site period*	*Period block*	*Site description*	*Sampling information*	*References*
Chapelfield Pit 5	9	2	late 7th–mid 6th millennium cal BC	M	3 pits (**only pit 5 securely dated and included in this analysis**)	hand collection, bulk samples, flotation, no further information available	Alldritt 2002; Atkinson 2002
Cnoc Coig	10	1	early 5th–early 4th millennium cal BC	LMII	**shell midden**, occupation surfaces, possible stake-built structures and hearths	3-stage cluster sampling; bulk samples and flotation to 1mm; all soil wet-sieved to 3mm	Boyd & Kenworthy 1991–2:18; Mellars 1978, 1979, 1987; Peacock 1978;
Cramond	11	2	early–late 9th millennium cal BC	LMI	lithic scatter, **old ground surfaces**, **pits**, **a scoop and stake-holes (phase 1 & 2 only in this analysis)**	100% sampling, bulk samples, flotation	Hastie 2003b; Lawson 2001; Reed 1995; Saville 2008
Daer Valley Site 84	12	2	late 5th millennium cal BC	LMII	old ground surface, **a pit** and a lithic scatter	total sampling, bulk samples, flotation to 1mm	Ward 2005a, 2005b, 2005c
East Barns	13	2	late 9th–early 8th millennium cal BC	LMI	**sunken floor** with post-holes and **burnt walling** around it and **a possible hearth**, stake-holes and slot features within floor (oval structure with internal furniture), and **pits** and **an occupation horizon** around structure	bulk samples, flotation, no further information available	Gooder 2007; Hall 2002
Elginhaugh	14	2	associated with Mesolithic artefacts	M	lithic concentration in sand layer and **natural feature**, no definite anthopogenic features	judgement sampling, bulk samples, flotation	Clapham 2007; Hanson 2007

Site	*Site number*	*Woodland zone*	*Site period*	*Period block*	*Site description*	*Sampling information*	*References*
Fife Ness	15	2	early 8th–late 8th millennium cal BC	LMI	**occupation layer**, **pits**, shallow scoops, linear cut, possible hearth, curving line of pits (possible windbreak structure)	total sampling, bulk samples, flotation	Holden 1996; Wickham-Jones & Dalland 1998a, 1998b
Fordhouse Barrow	16	2	early: mid 8th–early 7th millennium cal BC; late: mid–late 5th millennium cal BC	Early: LMI; Late: LMII	**pits and old ground surfaces** beneath barrow	no information available	Peterson & Proudfoot 1996, 1997; Proudfoot 1999, 2001
Gallow Hill	17	2	late–mid 5th millennium cal BC	LMI	**pits** and a lithic scatter	no information available	Donnelly & Macgregor 2005; Miller 2005
Garthdee	18	1	early–mid 5th millennium cal BC	LMII	**a pit**	100% sampling, bulk samples, flotation	Murray & Murray forthcoming; Timpany 2008
Glenbatrick Waterhole	19	1	associated with Mesolithic artefacts	M	**occupation layer** and lithic scatter	no information available	Mercer 1972–4
Irish Street	20	2	associated with Mesolithic artefacts	M	lithic scatter in a **layer and cut feature** containing post-holes and stake-holes (possible wind break or drying rack)	dry sieving to 5mm; no further information available	Mackenzie et al 2002
Kilellan Farm	21	1	associated with Mesolithic artefacts	M	areas of laid pebbles and flat stones, a pit and lithic scatter **in sand layer**	bulk samples, no further information available	Boardman 2005; Ritchie 2005
Kinloch	22	1	late 9th–late 7th millennium cal BC	LMI	**pits**, post-holes, **hollows**, stake-holes, slots and lithic scatter	no sampling, soil sieved to 3mm	Wickham-Jones et al 1990

Site	*Site number*	*Woodland zone*	*Site period*	*Period block*	*Site description*	*Sampling information*	*References*
Lealt Bay	23	1	associated with Mesolithic artefacts	M	lithics and ecofacts in **gravel/sand layers**	no sampling, main occupation horizon partially wet sieved to 3mm	Mercer 1967–8
Links House	24	3	late 8th–early 7th millennium cal BC	LMI	lithic scatter, **stake-holes**, **post-holes**, **pits**, hollows, **natural features and thin occupation layers** (stake and post structures, external structures)	100% sampling of features, bulk samples, flotation, top soil 100% wet sieved to 4mm	Alldritt 2011; Lee & Woodward 2008, 2009a, 2009b; Woodward 2008
Littlehill Bridge	25	2	late 7th millennium cal BC	LMI	**scooped features**, occupation deposit and lithic scatter	bulk samples, flotation, no further information available	Macgregor et al 2001; Miller & Ramsay 2001
Lon Mor	26	1	late 7th–early 4th millennium cal BC	M	**organic rich horizon** containing artefacts and ecofacts	no information available	Bonsall et al 1993; Bonsall 1996
Long Howe	27	3	late 8th–early 7th millennium cal BC	LMI	**old ground surface** beneath a barrow	total sampling, bulk samples, flotation	Robertson & Woodward 2007; Wickham-Jones & Downes 2007
Lussa Wood	28	1	late 9th–mid 7th millennium cal BC	LMI	**3 conjoined stone rings in a scoop**, area of flat stones and **occupation layers**	no sampling, soil wet sieved to 3mm	Mercer 1978–80; Moore 1978–80
Manor Bridge	29	2	mid 9th–early 8th millennium cal BC	LMI	lithic scatter, cobble area and **possible pit**	bulk samples, flotation, no further information available	Hastie 2002; Warren 1998, 2003; Graeme Warren pers comm

Site	*Site number*	*Woodland zone*	*Site period*	*Period block*	*Site description*	*Sampling information*	*References*
Morton	30	2	Morton A:mid 8th–early 5th millennium cal BC; Morton B: early 6th–early 5th millenium cal BC	Morton A: M; Morton B: LMII	Morton A: lithic scatters, **occupation floors**, **hearths** and stakeholes (possible shelters/windbreaks); Morton B: **shell midden** incorporating hearths, stake-holes, post-holes and stone walling	Site A = hand collection; Site B = judgement sampling, bulk samples, flotation	Coles 1971
Newton	31	1	late 8th–late 7th millennium cal BC	LMI	**gullies**, pits and **depression** containing artefacts and ecofacts (possible structure)	bulk samples, flotation to 0.35mm, no further information available	McCullagh 1989a, 1989b
North Carn	32	1	mid–late 7th millennium cal BC	LMI	lithic scatter, scoops and an **L-shaped stone setting in an old land surface**	some soil sieved, no further information available	Mercer 1971–2
Northton 2001/2010	33	3	late 8th–late 7th millennium cal BC	LMI	**old ground surface** containing artefacts and ecofacts	total sampling, bulk samples, flotation	Bishop et al 2010, 2011; Bishop 2013; Gregory et al 2005; Simpson et al 2006
Redkirk Point	34	2	late 8th–mid 7th millennium cal BC	LMI	**hearth** within shallow hollow	bulk samples, sieving, no further information available	Masters 1981
Silvercrest	35	1	post-circle 1: late 7th–early 6th millennium cal BC; post-circle 2: mid–late 8th millennium cal BC	Silver-crest 1 & 2: LMI	**2 post-circle structures** and a possible post alignment	bulk samples, flotation, no further information available	Cressey & Lyons forthcoming; Cressey & Suddaby 2002; Suddaby 2007

Site	*Site number*	*Woodland zone*	*Site period*	*Period block*	*Site description*	*Sampling information*	*References*
Sketewan	36	2	mid–late 7th millennium cal BC	LMI	70 possible **pits/tree** holes in old land surface	bulk samples, no further information available	Dickson 1997; Mercer & Midgley 1997
Skilmafilly	37	1	mid 5th–early 4th millennium cal BC	LMII	**a large pit**	total sampling, bulk samples, flotation	Cressey 2003, 2012; Hastie 2003a, 2012; Johnson & Cameron 2012
Smittons	38	2	mid 6th–late 5th millennium cal BC	LMII	lithics scatter, **fire spots** and arc of stake-holes	no information available	Affleck 1983; Edwards 1996b
Spurryhillock	39	2	early–late 5th millennium cal BC	LMII	**a pit**	hand collection, judgement sampling, bulk samples, flotation	Alexander et al 1997; Clarke 1997
Staosnaig	40	1	F24: late 8th–early 6th millennium cal BC; F41 & F49: late 8th–late 7th millennium cal BC; F30: late 5th millennium cal BC	F24: M; F41 & F49: LMI; F30: LMII	**pits**, a hearth and **a large pit** containing a post-hole (probable hut reused for disposing of knapping debitage and plant processing debris)	feature F24:25–50% random sampling of 0.5m grid squares, bulk samples and flotation; other features: wet sieved to to 3mm	Carruthers 2000; Hather 2000b; Mason & Hather 2000; Mithen 2000; Mithen et al 2001
Summerston	41	2	late 5th millennium cal BC	LMII	**a post-pit**	no information available	Baker 1998
Temple Bay	42	3	early-mid 6th millennium cal BC	LMII	**old ground surfaces** containing artefacts and ecofacts	100% sampling, bulk samples, flotation	Blake et al 2012b; Church et al 2011a; 2012a
Tràigh na Beirigh 1	43	3	late 5th millennium cal BC	LMII	**shell midden**	100% sampling, bulk samples, flotation	Blake et al 2012a; Church et al 2011b; 2012b

Site	*Site number*	*Woodland zone*	*Site period*	*Period block*	*Site description*	*Sampling information*	*References*
Tulloch Wood	44	1	pit 1: early–mid 6th millennium cal BC; pit 2: early–late 6th millennium cal BC; pit 3: early–late 5th millennium cal BC	Pits 1–3: LMII	**pits**	judgement sampling, bulk samples, flotation	Carter 1993
Ulva Cave	45	1	early 7th–late 5th millennium cal BC	M	**shell midden**	column samples, dry sieving to 2mm, no further information available	Bonsall et al 1991, 1992, 1994; Russell et al 1995
Upper Largie	46	1	mid–late 5th millennium cal BC	LMII	**pits and post-holes**	bulk samples, flotation, no further information available	Gale 2007; Cook et al 2010; Vandorpe 2007
Warren Field	47	1	pit 5: late 8th–mid 6th millennium cal BC; other pits: late 9th–mid 8th millennium cal BC	pit 5: M; other pits: LMI	**pit alignment**	bulk samples, flotation, no further information available	Hastie 2004; Lancaster 2009; Murray et al 2009; Timpany 2006
Weston Farm	48	2	early: late 6th–early 5th millennium cal BC; late: late 8th–early 7th millennium cal BC	Early: LMI; Late: LMII	lithic scatter, **pits**, **old ground surface** containing artefacts and ecofacts	bulk samples, flotation, every feature sampled	Ward 2005d, 2006

were from undated contexts securely associated with Mesolithic artefactual material. Undated plant remains from unsecure contexts containing radiocarbon dated material of both Mesolithic and later date or concentrations of cereal grains or post-Mesolithic artefacts were also excluded from the review. In addition, radiocarbon dated Mesolithic plant remains in contexts clearly of post-Mesolithic date were excluded. However, directly dated Mesolithic plant remains from secure contexts were included if only a single intrusive cereal grain or radiocarbon date of post-Mesolithic date was present.

GEOGRAPHICAL AND CHRONOLOGICAL SITE CLASSIFICATIONS

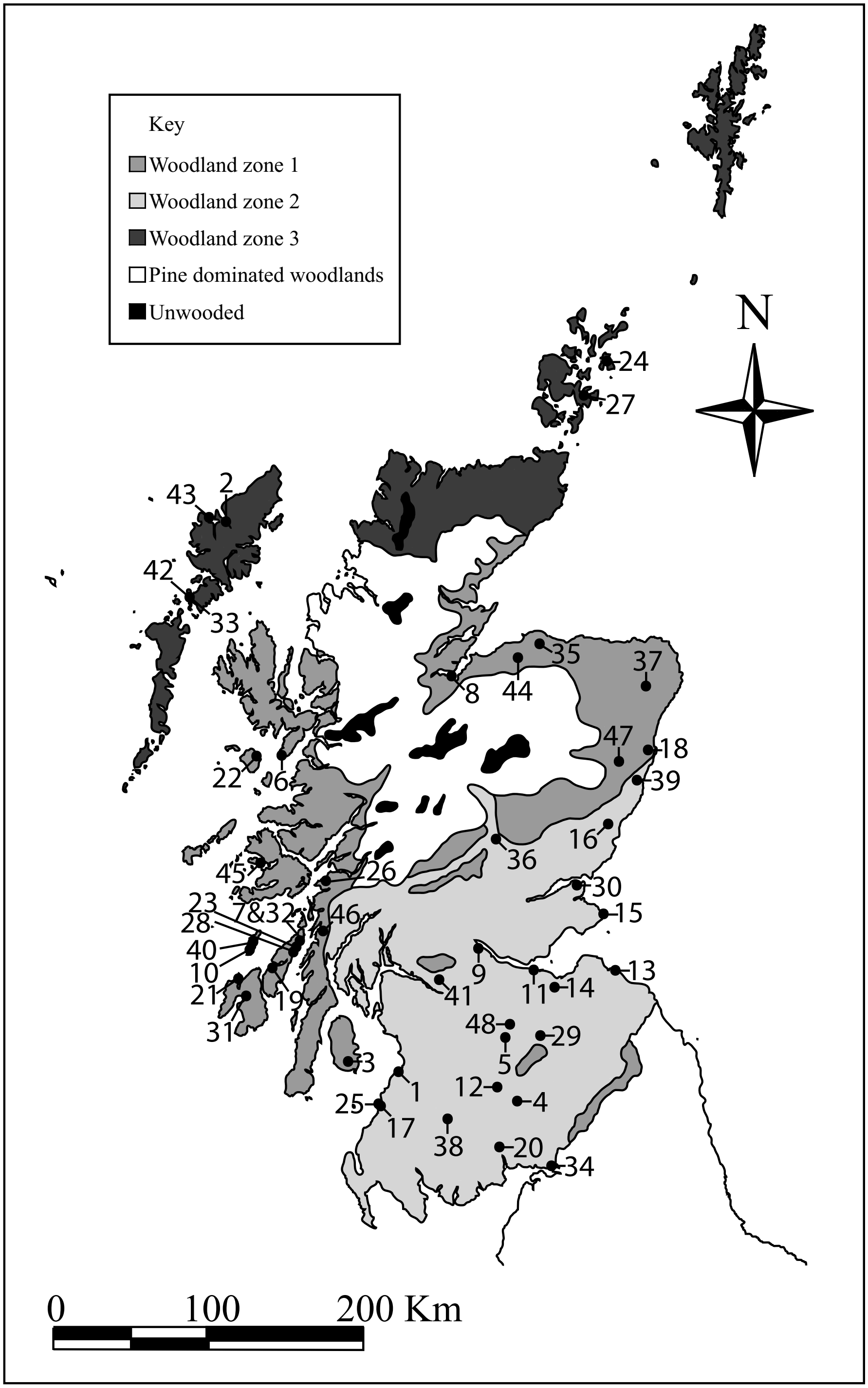
On the basis of changes in material culture, the Later Mesolithic in Britain is currently accepted to have begun at about 8400 cal BC (Saville 2008; Passmore & Waddington 2012: 121). Whilst several Scottish sites (Morton A, Glenbatrick Waterhole, Lussa Bay and An Corran) have produced artefactual assemblages typologically similar to material from radiocarbon dated Early Mesolithic English sites, these assemblages are not associated with Early Mesolithic radiocarbon dates and there are currently no Mesolithic sites with secure radiocarbon dates from before *c* 8600 cal BC (Ashmore 2004b; Saville 2004: 205). Consequently, the sites in this paper were classified according to radiocarbon chronologies only.

In order to assess whether there were any chronological trends in the dataset, uncalibrated radiocarbon dates from each site were calibrated using IntCal13 (Reimer et al 2013), within OxCal v4.2 (Bronk Ramsey 2009). Since the Later Mesolithic of Scotland cannot be subdivided on the basis of artefact typologies (Mithen 2000: 601; Saville 2004: 205), each site was classified as Later Mesolithic I (8600–6000 ± 20 cal BC) or Later Mesolithic II (6000–4000 ± 20 cal BC) using the arbitrary date of 6000 cal BC as the divider between these periods. Where possible, different site contexts were separated into these chronological categories and the totals for each period from each site were listed as separate 'site blocks'. Sites or contexts that could not be placed into these period blocks, due to an absence of radiocarbon dates or an insufficiently tight radiocarbon chronology, were classed as Mesolithic (8600–4000 ± 20 cal BC). Therefore, three chronological categories were used: Later Mesolithic I, Later Mesolithic II and Mesolithic. These chronological groupings are clearly very coarse, but finer chronological categories were not possible for two main reasons. Firstly, some dates spanned multiple millennia, making the division of sites into millennium-scale categories problematic. Secondly, it was not always clear how undated plant remains related to the different site phases when radiocarbon dates from other materials spanned several millennia.

The sites were further divided into three geographical categories based on Tipping's (1994; 2004) woodland classification scheme for the period *c* 4000 cal BC: woodland zone 1 (Inner Hebrides, West Coast Mainland and North-East Scotland), woodland zone 2 (Southern and Central Scotland), and woodland zone 3 (Northern and Western Isles of Scotland) (see illus 1). Tipping's (1994; 2004) 'pine & pine/birch woods' zone was excluded from the analysis because no Mesolithic sites with archaeobotanical remains were present in this area. Whilst it is recognised that the vegetation changed considerably between 8000–4000 cal BC, these zones represent useful geographical regions for comparison, reflecting the major woodland zones available for wild plant exploitation. Where possible, site features that were clearly spatially distinct were separated, and the totals for each spatial area from each site were listed as separate 'site blocks'.

DATA RECORDING AND ANALYSIS

For each site in the review, the abundance of each plant taxon present within each assemblage was recorded numerically where possible and



Illus 1 Map of Scotland showing Mesolithic site locations. Numbers correspond to the sites listed in Table 1 and woodland zones are taken from Tipping (1994; 2004)

on a scale of 'present' ('P'), absent (blank), or 'abundant' ('A') when plant components were not numerated in the archaeobotanical reports. The sampling methodologies employed and background information about each site was also recorded to aid the comparison between different sites (Table 1). The archaeobotanical species identifications were summarised by grouping the plant taxa into different categories (a full list of the plant taxa and components in each of these categories is given in Table 2). Nomenclature for the scientific names follows Stace (2010). The term 'seeds' is used in the text to include all small botanical fruits/nuts: achenes, fruits, nuts and caryopses (Table 2). Plant species classed as 'cf' were added to the definite species identifications, for example cf *Malus sylvestris* (L.) Mill. was placed in the crab apple seed/fruit fragment category (Table 2). Quantification in Tables 3–6 was, where possible, based on numerical counts of plant components presented in the archaeobotanical reports. The masses of hazelnut shell were also noted, where this information was available, because identifications were not universally presented as numerical counts in the archaeobotanical reports. Seed totals for plants with edible and inedible components are given in Table 3. Species identifications for plants with edible seeds and seeds from plants with edible leaves, stems, shoots, flowers and roots are shown in Tables 4 and 5 respectively. Seeds from inedible plants and seeds identified at too high a taxonomic level to be certain of edibility are listed in Table 6.

It was not possible to use semi-quantitative or quantitative methods to analyse the plant macrofossil dataset because there were major discrepancies in the sampling, recovery and recording methods employed between different sites. Also, the differential fragmentation of different types of plant remains means that quantitative methods would have been unsuitable for comparing different plant components, such as seeds and tubers. Direct quantitative comparisons between different sites would also have been problematic because plant remains were only present in low frequencies in most assemblages. Additionally, the plant remains from some sites probably represent palimpsests of multiple behavioural episodes and periods of site use. Consequently, in this review, the plant macrofossil data will be considered on a presence/absence basis only.

In order to provide a more detailed consideration of the role of plants within Mesolithic economies and to understand the likely harvesting, processing and cooking methods used for specific plants, a wide range of relevant ethnobotanic sources were utilised. A full list of the ethnobotanical sources systematically consulted is given in Appendix 1.

RESULTS

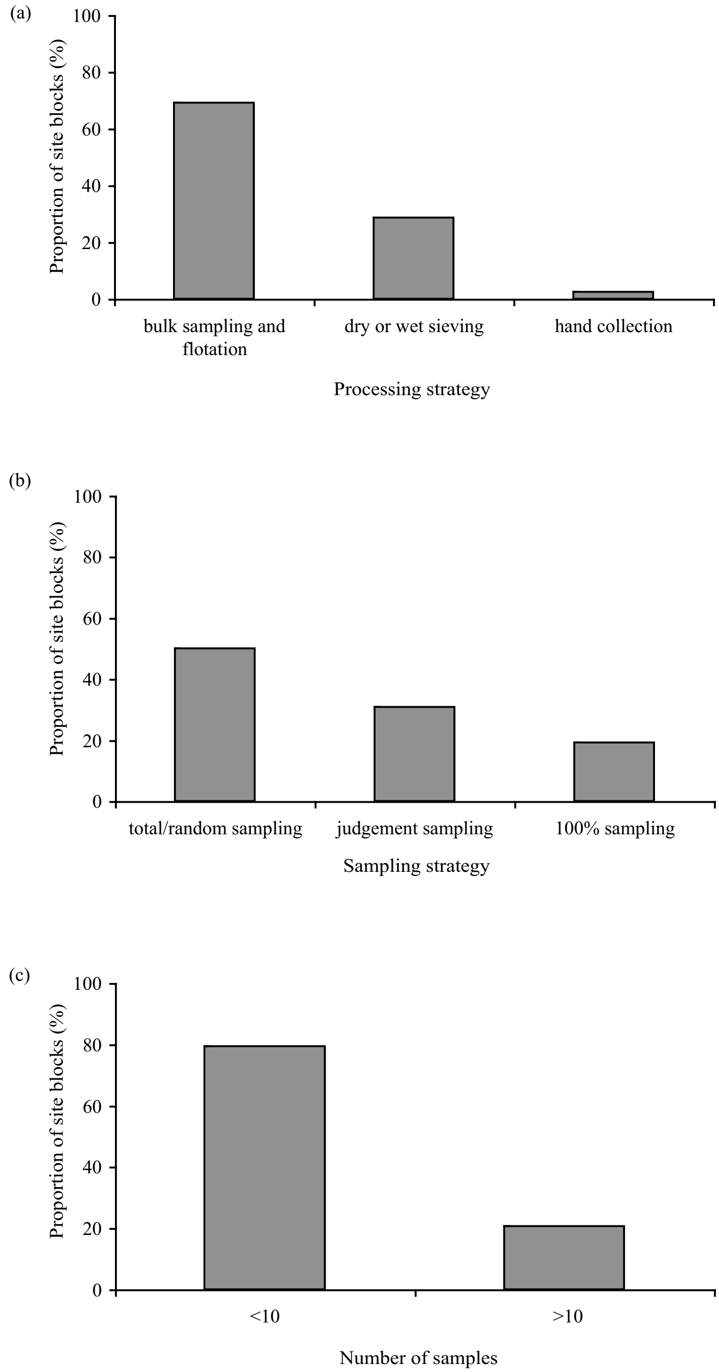
This section presents the results of the review of 48 Scottish Mesolithic sites with archaeobotanical remains, split into 57 site blocks (Table 1). Of these site blocks, 24 were classed as Later Mesolithic I, 20 as Later Mesolithic II and 13 as Mesolithic. There was an even spread of sites in woodland zones 1 and 2, with 21 sites located in each zone (illus 1). In contrast, there are currently only six Mesolithic sites with archaeobotanical remains in woodland zone 3, an area encompassing the north of Sutherland, Caithness and the Northern and Western Isles. The small number of sites in woodland zone 3 is a reflection of the lower level of modern development in this region compared to other areas of Scotland. Also, in situ Mesolithic archaeology has only been discovered in the Northern and Western Isles in the last decade and so it is only recently that there has been any systematic search for Mesolithic sites in this area (Bishop et al 2010; 2011; Church et al 2012a; 2012b).

The plant remains were recovered from a range of different feature types, which are representative of the diversity of Mesolithic features present across Scotland. These include:

pits, post-holes, scoops, stake-holes, hearths/fire spots, gullies, old ground surfaces/occupation horizons, shell middens and possible natural features (Table 1).

Of the 42 site blocks reviewed that noted the sample processing procedure, bulk sampling and flotation was undertaken on 29 site blocks, dry or wet sieving at 12 site blocks and hand collection only at one site block (illus 2a). Of the 12 site blocks using dry or wet sieving, all seven site blocks that mentioned the mesh size used a mesh ≥2mm, which would prevent the recovery of most charred seed remains. Most reports did not record the type of sampling strategy employed (van der Veen 1984: 193; Jones 1991b: 57), but for the 25 site blocks where this information was noted, 13 used total/random sampling, eight judgement sampling and five were 100% sampled (illus 2b). Small numbers of samples were analysed from most sites, with the majority of the assemblages deriving from fewer than 10 samples (illus 2c). Counts/weights of edible plant remains were only available for 18 site blocks.

Edible plant remains were present on most sampled sites and only 10 of the sampled site blocks produced wood charcoal without edible remains. Overall, hazel (*Corylus avellana* L.)



Illus 2 Sampling and processing strategies used on Scottish Mesolithic sites, where this information was provided in the reports: (a) processing strategy (N = 42), (b) sampling strategy (N = 26), and (c) number of Mesolithic samples (N = 29)

TABLE 2
Common and scientific names of plant components included in each plant group in Tables 3–6

Plant group	*Common name*	*Latin name*	*Plant part*
Hazelnut shell	Hazelnut	*Corylus avellana* L.	Nutshell
Whole hazelnut	Hazelnut	*Corylus avellana* L.	Cotyledon
Lesser Celandine tuber/bulbil	Lesser celandine	*Ficaria verna* Huds. (ssp. *fertilis*/ssp. *verna*)	Root tuber
Lesser Celandine tuber/bulbil	Lesser celandine?	cf *Ficaria verna* Huds. (ssp. *fertilis*/ ssp. *verna*)	Root tuber
Lesser Celandine tuber/bulbil	Lesser celandine	*Ficaria verna* Huds. (ssp. *verna*)	Bulbils
Unidentified parenchyma/root/ vesicular material	Aggregate parenchyma	n/a	Parenchyma
Unidentified parenchyma/root/ vesicular material	Aquatic aerenchyma	n/a	Aerenchyma
Unidentified parenchyma/root/ vesicular material	Aquatic aerenchyma?	n/a	Aerenchyma
Unidentified parenchyma/root/ vesicular material	Tap root	n/a	Tap root
Unidentified parenchyma/root/ vesicular material	Tap root?	n/a	Tap root
Unidentified parenchyma/root/ vesicular material	Unidentified parenchyma	n/a	Parenchyma
Unidentified parenchyma/root/ vesicular material	Vesicular parenchyma	n/a	Parenchyma

Plant group	*Common name*	*Latin name*	*Plant part*
Unidentified parenchyma/root/ vesicular material	Vitreous/vesicular carbonised material	n/a	Parenchyma/seaweed/processed plant material fragment
Stem/rhizome	Grass stem?	cf Poaceae family	Stem
Stem/rhizome	Indeterminate rhizome	n/a	Rhizome
Stem/rhizome	Indeterminate stem	n/a	Stem
Seaweed fragment	Knotted wrack seaweed?	cf *Ascophyllum nodosum* (L.) Le Jolis	Seaweed
Hawthorn stone	Hawthorn?	cf *Crataegus monogyna* Jacq.	Fruit stone
Hawthorn stone	Hawthorn genus?	cf *Crataegus* sp.	Fruit stone
Crab Apple seed/fruit fragment	Crab apple	*Malus sylvestris* (L.) Mill.	Seed
Crab Apple seed/fruit fragment	Crab apple?	cf *Malus sylvestris* (L.) Mill.	Seed
Crab Apple seed/fruit fragment	Crab apple	*Malus sylvestris* (L.) Mill.	Pericarp
Pear pip	Pear genus?	cf *Pyrus* sp.	Seed
Seeds from other edible species	Orache genus	*Atriplex* sp.	Seed
Seeds from other edible species	Common orache	*Atriplex patula* L.	Seed
Seeds from other edible species	Sedge genus	*Carex* sp.	Nut
Seeds from other edible species	Fat-hen	*Chenopodium album* L.	Seed
Seeds from other edible species	Spike-rush genus?	cf *Eleocharis* sp.	Nut
Seeds from other edible species	Black-bindweed	*Fallopia convolvulus* (L.) Á. Löve	Nut
Seeds from other edible species	Cleavers	*Galium aparine* L.	Fruit

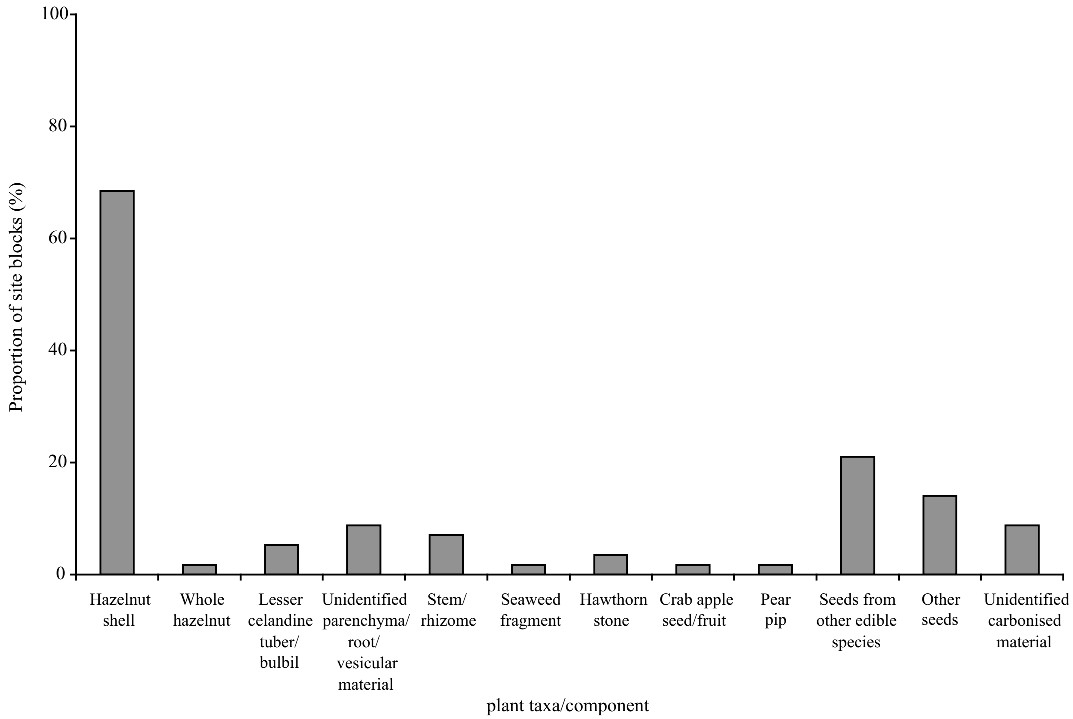
Plant group	*Common name*	*Latin name*	*Plant part*
Seeds from other edible species	Ribwort plantain	*Plantago lanceolata* L.	Seed
Seeds from other edible species	Knotgrass	*Polygonum aviculare* L.	Nut
Seeds from other edible species	Meadow buttercup/creeping buttercup/ bulbous buttercup	*Ranunculus acris*/*repens*/*bulbosus* L.	Achene
Seeds from other edible species	Dock genus	*Rumex* sp.	Nut
Seeds from other edible species	Charlock	*Sinapis arvensis* L.	Seed
Seeds from other edible species	Corn spurrey	*Spergula arvensis* L.	Seed
Seeds from other edible species	Common chickweed	*Stellaria media* (L.) Vill.	Seed
Seeds from other edible species	Vetch/tare genus	*Vicia* sp.	Seed
Seeds from other edible species	Vetch/tare genus?	cf *Vicia* sp.	Seed
Seeds from other edible species	Vetch/tare genus	*Vicia*/*Lathyrus* sp.	Seed
Seeds from other edible species	Vetch/tare genus?	cf *Vicia*/*Lathyrus* sp.	Seed
Seeds from other edible species	Violet genus	*Viola* sp.	Fruit
Other seeds	Grass family	Poaceae family	Caryopsis
Other seeds	Goosefoot family	Chenopodiaceae family	Achene
Other seeds	Sun spurge	*Euphorbia helioscopia* L.	Seed
Other seeds	Bluebell?	cf *Hyacinthoides non-scripta* (L.) Chouard ex Rothm.	Seed
Other seeds	Wood-rush genus?	cf *Luzula* sp.	Seed

Plant group	*Common name*	*Latin name*	*Plant part*
Other seeds	Slender naiad	cf *Najas flexilis* (Willd.) Rostk. & W. L. E. Schmidt	Fruit
Other seeds	Annual knawel	*Scleranthus annuus* L.	Calyx
Other seeds	Branched bur-reed	*Sparganium erectum* L.	Seed
Other seeds	Indeterminate seeds	n/a	Seed
Unidentified carbonised material	Unidentified carbonised material	n/a	All unidentified carbonised macroplant remains

nutshells were by far the most frequent edible plant species recovered. In fact, hazelnut shell was virtually ubiquitous and it was present at 39 of the 57 site blocks in this review (illus 3). Many assemblages also contained large quantities of nutshell, with particularly notable concentrations coming from Staosnaig on Colonsay and Cramond, East Barns and Weston Farm in Southern Scotland. There was no chronological trend in terms of the presence of large concentrations of hazelnuts, but there was a decline in the presence of hazelnuts between the Later Mesolithic I and Later Mesolithic II sites: hazelnut shell was present on 83% of Later Mesolithic I site blocks and 50% of Later Mesolithic II site blocks.

At first sight this appears to support Ashmore's (2004a: 89) suggestion that there may have been a decline in the number of sites with hazelnuts between 6000–4000 cal BC. However, the apparent decline in the abundance of hazelnut shell is probably a function of the small size of many of the Later Mesolithic II sites and the consequent low volume of soil processed at these sites; where low volumes of soil are processed, the chance of recovering non-charcoal plant remains is considerably reduced. Furthermore, it is likely that the decline in the number of radiocarbon dates on hazelnut shell after *c* 6000 cal BC (Ashmore 2004a: 89) was a result of the relative abundance of shell midden contexts on the Later Mesolithic II sites and the lack of sampling for plant remains on these sites. Added to this was the choice of material for radiocarbon dating, with many shell middens frequently dated using shell or bone, and several sites dated using charcoal, despite hazelnut shell being present.

Other edible species were much more scarce (illus 3). With the exception of one site – Staosnaig – no sites had more than 30 plant remains from other edible species and many taxa were only represented by a single identification. There is some evidence that the inhabitants of Mesolithic Scotland exploited a diversity of edible plants. A range of edible fruit species



ILLUS 3 Summary of the main plant components present on Scottish Mesolithic sites (N = 57)

– hawthorn (cf *Crataegus monogyna* Jacq./cf *Crataegus* sp.), crab apple (*Malus sylvestris* (L.) Mill.) and pear (cf *Pyrus* sp.) – have been recovered from four sites (Table 3) and a variety of edible seeds were present on nine site blocks (Table 4). The archaeobotanical seed remains from plants with edible leaves, shoots, stems or roots, which may have been eaten in the Mesolithic, have also been found on nine site blocks (Table 5). The seeds of several species that are probably not edible were also present in four assemblages (Table 6).

Edible roots and seaweed have only been identified to species level at two Scottish Mesolithic sites (Table 3). At Staosnaig, the edible root tubers of lesser celandine were recovered together with the remains of aquatic rhizomes, seaweed fragments and fleshy tap roots, which may also have been edible. Initial assessment of the carbonised plant remains from recent excavations at Northton, Harris has revealed that edible roots, including lesser celandine, formed part of the assemblage (Table 3). The analysis of this assemblage is on-going and will form the subject of a future paper. The presence of vesicular material and unidentified roots/stems/rhizomes at two other sites, suggests that edible roots/tubers may also have been present on other Mesolithic sites.

PLANT GATHERING, PROCESSING AND COOKING IN THE SCOTTISH MESOLITHIC

RECOGNISING WILD FOOD PLANTS IN ARCHAEOBOTANICAL ASSEMBLAGES

Plants that were consumed in the past may become charred in domestic fires during processing for consumption or storage by a range of techniques, such as grinding, pounding, roasting, boiling or drying (Minnis 1981: 145;

TABLE 3
Summary of the plant macrofossils present at Scottish Mesolithic sites; where possible each site is split into chronological blocks (see Methodology section). P: present; A: abundant. Except where otherwise indicated, numbers refer to numerical counts of plant components. For a description of the woodland zone classifications see Methodology section. Site numbers correspond to site locations in illus 1

Site	*Site number*	*Woodland zone*	*Hazelnut shell*	*Whole hazelnut*	*Lesser celandine tuber/ bulbil*	*Unidentified parenchyma/ root/vesicular material*	*Stem/rhizome*	*Seaweed fragment*	*Hawthorn stone*	*Crab apple seed/fruit fragment*	*Pear pip*	*Seeds from other edible species*	*Other seeds*	*Unidentified carbonised material*
Later Mesolithic I														
Ailsa View	1	2	459 (10.35g)						1					
Auchareoch	3	1	P											
Camas Daraich	6	1	8											
Cramond Phases 1–2	11	2	120/161 samples											
East Barns	13	2	>234.38g (sample volume = 246.8 litres)											
Fife Ness	15	2	P			P								
Fordhouse Barrow (E)	16	2	P											
Gallow Hill	17	2	P											
Kinloch	22	1	P											
Links House G3–5	24	3	44 (1.03g)			1	2							
Littlehill Bridge	25	2	P									P	P	

Site	*Site number*	*Woodland zone*	*Hazelnut shell*	*Whole hazelnut*	*Lesser celandine tuber/ bulbil*	*Unidentifed parenchymal/ root/vesicular material*	*Stem/rhizome*	*Seaweed fragment*	*Hawthorn stone*	*Crab apple seed/fruit fragment*	*Pear pip*	*Seeds from other edible species*	*Other seeds*	*Unidentifed carbonised material*
Long Howe	27	3	P				3							
Lussa Wood	28	1	P											
Manor Bridge	29	2	5/7 samples											
Newton	31	1	P										3	
North Carn	32	1	P											
Northton 2001	33	3	31 (sample volume = 85 litres)				1						2	
Northton 2010 *	33	3	P		P	P						P	P	
Silvercrest circle 1	35	1										1		
Staosnaig F41 & 49	40	1	>553.6g (sample volume = 152 litres)		2	1						1		
Warren Field (Other pits)	47	1	1									1		
Weston Farm (early)	48	2	574											
Later Mesolithic II														
Aird Calanais	2	3	3 (sample volume = 28 litres)											

Site	*Site number*	*Woodland zone*	*Hazelnut shell*	*Whole hazelnut*	*Lesser celandine tuber/ bulbil*	*Unidentified parenchyma/ root/vesicular material*	*Stem/rhizome*	*Seaweed fragment*	*Hawthorn stone*	*Crab apple seed/fruit fragment*	*Pear pip*	*Seeds from other edible species*	*Other seeds*	*Unidentified carbonised material*
Cnoc Coig	10	1	A											P
Fordhouse Barrow (L)	16	2	P											
Morton B	30	2										26	1	
Skilmafilly	37	1										1	1	
Smittons	38	2	P											
Spurryhillock	39	2												P
Staosnaig F30	40	1	25.4g (sample volume = 36 litres)											
Summerston	41	2	P											
Temple Bay*	42	3	P											P
Tràigh na Beirigh 1*	43	3	P											P
Tulloch Wood 3	44	1	1 (sample volume = 68 litres)											
Upper Largie	46	1											4	
Weston Farm (late)	48	2	954											

Site	*Site number*	*Woodland zone*	*Hazelnut shell*	*Whole hazelnut*	*Lesser celandine tuber/ bulbil*	*Unidentified parenchyma/ root/vesicular material*	*Stem/rhizome*	*Seaweed fragment*	*Hawthorn stone*	*Crab apple seed/fruit fragment*	*Pear pip*	*Seeds from other edible species*	*Other seeds*	*Unidentified carbonised material*
Mesolithic														
Carn Southern	7	1	P								1?			
Castle Street	8	1	P											
Chapelfield Pit 5	9	2							1			18		
Elginhaugh	14	2										1		
Glenbatrick Waterhole	19	1	P											
Irish Street	20	2	2											
Lealt Bay	23	1	13											
Lon Mor	26	1	P											
Morton A	30	2	P									1		
Staosnaig F24	40	1	*c* 15848g (*c* 30–40,000 whole nuts)	1	412	>62	>2	1		21		33	11	
Ulva Cave	45	1	0.8g (sample mass = 251kg)											P
Warren Field (Pit 5)	47	1										3		

* NB: initial sample assessment only: analysis ongoing.

Stahl 1989: 172; King 1994: 189; van der Veen 2007: 979). They may also become carbonised accidentally during storage or if fires were lit on top of former processing areas, and deliberately if the waste products were burnt as a fuel (Minnis 1981: 145; van der Veen 2007: 979; Sievers & Wadley 2008: 2916).

Establishing which charred plant remains in Scottish Mesolithic assemblages were deliberately gathered for food and deposited as a result of these processes is highly challenging. There is no clear-cut distinction between edible and non-edible plants because the palatability of sour, bitter and astringent plants is culturally – and perhaps genetically – determined (Johns 1994: 46, 49; Ertuğ 2009: 68), factors which are clearly impossible to establish for past populations. Also, many species that are poisonous, harmful or unpalatable can be made edible through elaborate processing techniques (Johns 1994: 48). Such processing methods usually leave little archaeological trace and so it is usually difficult to discern whether these practices were undertaken in the Mesolithic. Even simple plant processing techniques, such as hearth or pit roasting, are difficult to identify archaeologically because hearths or pit features can be used for multiple purposes and for cooking many different foodstuffs using divergent methods (King 1994: 191).

Historical or ethnographic evidence of wild plant gathering by modern hunter-gatherers in North America and by traditional farming peoples in Turkey, Europe and Russia, can give important information about the edibility and processing of specific plant species recovered from Scottish Mesolithic sites (Stoličná 2000: 195; Ertuğ 2009: 69). However, edibility does not necessarily equate to consumption in the Mesolithic since the range of food consumed by a social group is culturally defined and plants that were historically or ethnographically important may not have been important food sources in Mesolithic Scotland (Milner 2009: 74). It should also be noted that though wild plants were often minor dietary components, or considered only as ‘famine foods’ by some farmers (Fenton 2000: 192; Tardío et al 2006: 39), they may have been of great importance to hunter-gathering peoples reliant on wild resources. The use of ethnographic evidence to assess wild plant consumption in the past should therefore be treated with caution.

The remains of wild plants can also enter the archaeological record by a number of other taphonomic pathways, which may be unrelated or only partially related to domestic consumption. Wild plants may arrive on archaeological sites through non-anthropogenic sources, such as the wind or birds, and other animals may act as vectors for seeds either externally on their fur or internally via consumption (Minnis 1981: 145; Pearsall 2000: 502; Sievers & Wadley 2008: 2911). Seeds and other plant remains may also become transported accidentally onto archaeological sites attached to human hair or clothing. Similarly, isolated seeds can become worked down into earlier layers as a result of ploughing, or by burrowing earthworms or small mammals (Minnis 1981: 145) and so there is a possibility that species represented by single seed identifications may be intrusive into Mesolithic horizons. Considering the low frequency of many of the species identified in this review, it is conceivable that some of these plants were deposited without deliberate human collection in the Mesolithic.

Even plants that were deliberately brought onto Mesolithic sites by humans may have been collected for other purposes. Most wild plants have many potential non-edible uses: they may be used as medicines, cosmetics, toys or for dyeing, bedding, construction, tools, fuel, bedding, cordage, utensils, basketry and hunting poisons, and some species might have become deposited on archaeological sites as a result of these activities (Etkin 1994: 10; King 1994: 196; Tomlinson & Hall 1996; Moerman 1998; Fenton 2000:184). As Ertuğ (2009: 69) notes, ‘Almost all routine subsistence activities and their social organisation, as well as most

TABLE 4
Edible seeds present at Scottish Mesolithic sites; where possible, each site is split into chronological blocks (see Methodology section). P: present. Numbers refer to numerical counts of plant components

Site	*Black bindweed seed*	*Charlock seed*	*Corn spurrey seed*	*Dock seed*	*Fat-hen seed*	*Knotgrass nutlet*	*Orache seed*	*Ribwort plantain seed*	*Sedge nut*	*Vetch/tare seed*
Later Mesolithic I										
Littlehill Bridge		P								
Silvercrest circle 1										1
Warren Field (Other pits)					1					
Later Mesolithic II										
Morton B			*c* 10		4	3				
Skilmafilly									1	
Mesolithic										
Chapelfield Pit 5	1				10		7			
Morton A	1									
Staosnaig F24				2				1	1	9
Warren Field (Pit 5)										1

of the material objects that we encounter in the rural daily life, are somehow related to plants'.

Furthermore, plants can be consumed as part of ritual practices, rather than primarily for calorific purposes (Milner 2009: 80). For instance, if the Mesolithic pit alignment at Warren Field, Crathes was a symbolic monument (Table 1), then it is possible that the plant remains from the site became deposited as a result of 'ritual' rather than domestic activities. With the exception of Warren Field, all the sites in this review are considered primarily to provide evidence of 'domestic' economic activity. All of these sites are suggestive of temporary/semi-permanent settlement or specialised processing, tool production or other economic activities; though clearly so-called 'domestic/functional' activities may have been embedded with social and symbolic meaning (Brück 1999).

There is also no clear-cut distinction between plants used as foods and medicines. Ethnobotanical research in Europe and North-America suggests that many wild plants have traditionally been collected for multiple purposes and may be considered both food and medicines or 'medicinal foods' which were used to improve health or to prevent illnesses (Etkin 1994: 9–10; Moerman 1998: 16; Ertuğ 2000: 177; Pieroni 2005: 29; Tardío et al 2006: 38; Ertuğ 2009: 67; Carvalho & Morales 2010: 160, 164; Christanell et al 2010: 62; Nebel & Heinrich 2010: 183; Pieroni 2010: 41; Tardío 2010: 230). Nevertheless, different parts of the same plant were often used for food than those used for medicine (Moerman 1998: 16) and so the plant component preserved may provide a clue to whether the plant was collected for food in the Mesolithic.

ARCHAEOLOGICAL AND ETHNOBOTANIC EVIDENCE FOR PLANT GATHERING, PROCESSING AND COOKING IN THE SCOTTISH MESOLITHIC

As just discussed, plants can become deposited on Mesolithic sites as a result of a range of processes and it is not always clear if charred plant remains represent food remnants. Regnell (2012) proposes that there are three main conditions under which archaeobotanical remains can be clearly interpreted as representing anthropogenic exploitation, '(1) occurrences in very large quantities, (2) presence in an environment in which the plant does not belong naturally (ie appears as "exotic"), and/or (3) obvious signs of processing by humans'. He further notes that ethnological evidence also provides supporting evidence for human exploitation (ibid). The following section will consider the possible evidence (Tables 3–6) for the human collection of plants for consumption in Mesolithic Scotland through a consideration of the frequency of each species, the archaeological taphonomy and the ethnobotanic evidence for the use of each taxon. Since processing and cooking methods are difficult to identify using archaeological evidence, the likely processing methods and taphonomic pathway of each taxon into the archaeological record will also be considered using ethnobotanic evidence (Appendix 1).

Hazelnuts

Of all the species recovered from the Scottish Mesolithic plant assemblages, hazelnuts are the only indisputable foodstuff. Not only are hazelnut shells virtually ubiquitous on Scottish Mesolithic sites, they are also extremely abundant on several individual sites (Table 3). It is unthinkable that hazelnuts accumulated on domestic hearths on so many sites and in such large quantities by natural processes. The Mesolithic date of hazelnut consumption is also not in doubt, given that many nutshells from Scotland have been directly radiocarbon dated (Ashmore 2004b). Though some ethnographic accounts from Britain and North America note a few traditional medicinal uses for hazelnuts (Gerarde 1597: 1251; Moerman 1998: 181–2; Dickson & Dickson 2000: 260), historically they have primarily been used for food in Britain (Lightfoot 1777: 587; Hill 1941: 41;

TABLE 5
Seeds identified on Scottish Mesolithic sites from plants with edible leaves, stems, shoots, roots, flowers, sap and buds; where possible, each site is split into chronological blocks (see Methodology section). l: leaves, sh: shoot, st: stem, f: flower, r: roots/bulbs, sa: sap, b: buds. Numbers refer to numerical counts of plant components. References are for the edibility of each plant component and correspond to the ethnobotanic sources in Appendix 1

Site	*Buttercup achene*	*Charlock seed*	*Cleavers seed*	*Corn spurrey seed*	*Common chickweed seed*	*Dock seed*	*Fat-hen seed*	*Hawthorn fruit stone*	*Lesser celandine tuber/bulbil*	*Orache seed*	*Ribwort plantain seed*	*Sedge nut*	*Spikerush nutlet*	*Vetch/tare seed*	*Violet fruit*
Edible component	l?, r?	l, f	l, sh	l	l, st, sh	l?,sh?, st?	l, sh, st	l, b, f	l	l, sh	l	r?, st?	r?, sa?	sh?/r?	l?, f?, b?
References (see Appendix 1)	21, 22, 25, 32	8, 25, 28, 31, 32, 37	3, 12, 25, 29, 31, 35	25	3, 22, 23, 28, 29, 31, 35, 37	3, 9, 18, 20, 21, 22, 23, 28, 29, 31, 32, 33, 35, 37	3, 9, 18, 21, 22, 25, 28, 29, 30, 31, 32, 33, 35, 37	3, 25, 28, 29, 31, 32	22, 25	3, 12, 28, 29, 32, 33, 35	3, 25, 31	31, 33	33	3, 8, 9, 22, 25, 31, 33	9, 25
Later Mesolithic I															
Littlehill Bridge		P			P										
Staosnaig F41 & 49			1						2						
Warren Field (Other pits)							1								
Later Mesolithic II															
Morton B				*c* 10	2		4			7					
Skilmafilly												1			
Mesolithic															
Chapelfield Pit 5							10			7					
Elginhaugh	1														
Staosnaig F24			19			2			412		1	1		9	
Warren Field (Pit 5)													1	1	1

Howes 1948: 179; Loewenfeld 1957: 39; Cameron 1977: 70; Mabey 1997: 90; Milliken & Bridgewater 2004: 40) and are still collected for food by many in Britain today (Phillips 1983: 138; Mabey 2001: 122; Burrows 2005: 23; Irving 2009: 64). There is also considerable ethnographic evidence for the use of hazelnuts for food by modern hunter-gatherer groups in North America and Canada (Gunther 1973: 27; Hamel & Chiltoskey 1975: 37; Ebeling 1986: 209; Gilmore 1991: 22; Kuhnlein & Turner 1991: 18; Moerman 1998: 181–2; Marles et al 2000: 150), though the species exploited were American hazelnut (*Corylus americana* Walter), California hazelnut (*Corylus cornuta* ssp. *californica* (A. de Candolle) E. Murray) and beaked hazelnut (*Corylus cornuta* ssp. *cornuta*), rather than the native British hazel species (*Corylus avellana* L.), which is absent from North America (ibid; Flora of North America Editorial Committee 1993+).

Hazelnuts would have been gathered from the trees in September/October, using cut branches to bend down high hazel branches to pick the nuts or to shake loose ripe nuts, and ripe nuts would also have been gathered from the ground (Mabey 2001: 122; Burrows 2005: 23). The annual gathering and processing of hazelnuts may well have been a social experience involving groups of gatherers, as was often the case in 17th–19th century Britain (Mabey 1997: 90; Finlayson 2005: 38). However, the trees would not have been climbed to gather the nuts (*contra* Finlayson 2005: 30) because the nuts would have been difficult to reach at the ends of the slender branches whilst sitting in the trunk of the tree (Dickson & Dickson 2000: 258). Since not all nuts ripen simultaneously on a single tree, harvesting would most probably have been undertaken in a series of stages across an area of trees (Mason 1996a: 2). There may also have been differences in ripening times between different stands of trees (Talalay et al 1984: 348) and perhaps hunter-gatherers moved between different areas of woodland as the nuts ripened. Talalay et al (1984: 348) suggest that the optimal harvesting time (in terms of yield per hour) was after the leaves had fallen but while the ripe nuts were still retained on the trees, because of the higher visibility of the nuts. However, this does not take into account competition with other nucivorous species.

Hazelnuts can also be collected whilst green and immature in August (Howes 1948: 22) to reduce the competition with birds and rodents (Lightfoot 1777: 587; Carruthers 2000: 414). Red squirrels (*Sciurus vulgaris*), bank voles (*Clethrionomys glareolus*), wood mice (*Apodemus sylvaticus*) and great spotted woodpeckers (*Dendrocopos major*) all consume hazelnuts and though their remains are rare in the fossil and archaeological records from Mesolithic Scotland, their widespread presence in Scotland in the Mesolithic can be inferred by the fact that they can live in the habitats present during this period. They are also known from archaeological sites of post-Mesolithic date in Scotland and from sites of Mesolithic date elsewhere in the British Isles and they are currently present in the Scottish fauna (Corbet & Harris 1991; Kitchener 1998; Yalden 1999; Kitchener et al 2004; McCormick & Buckland 2003; RSPB 2014). Consequently, it is possible that hazelnuts may have been collected in a green (milk-ripe) state by Mesolithic hunter-gatherers in Scotland to maximise the hazelnut harvest (Carruthers 2000: 411; McComb 2009: 228; Holst 2010: 2874). In North America, hunter-gatherers often collected hazelnuts when they were still green and the green nuts were either eaten immediately without ripening or allowed to ripen in the sun for several days before being stored for winter use (Moerman 1998: 181; McComb 2009: 228). However, comparison of the Staosnaig nutshell with modern semi-ripe nutshell under an SEM suggests that the nuts at this site were gathered when fully ripe (Carruthers 2000: 412). Also, Loewenfeld (1957: 40) states that:

> Unripe nuts should not be picked, as they shrink when dried, lose their pleasant flavour and soon become mouldy. As they store best if picking is delayed until some of the nuts begin to fall, it is a good idea to inspect the hazel bushes daily if possible, and collect the nuts which have fallen until those on the bush are ready to be picked. But as squirrels, dormice and the nuthatch are just as interested in hazelnuts as we are, it would not do to allow them to go on falling for too long.

Furthermore, green nuts are more time-consuming to process than ripe nuts because the husks adhere more tightly to the nuts (Talalay et al 1984: 351). Consequently, it is probable that ripe hazelnuts were of greater importance to hunter-gatherers than green nuts in Mesolithic Scotland. There are several practices that could result in the deposition of charred nutshell on Mesolithic sites, of which cooking was probably a major cause. Hazelnuts can be difficult to digest in large quantities (Gerarde 1597: 1251; Mears & Hillman 2007: 26), and so it is probable that cooking was necessary to make hazelnuts suitable for use as a staple food. Ethnographic evidence suggests that though hunter-gatherers often ate hazelnuts raw, they were also frequently roasted, boiled in soups, cooked into a mush or ground and mixed with other ingredients to make bread or cakes (Gunther 1973: 27; Ebeling 1986: 209; Gilmore 1991: 22; Moerman 1998: 181; Marles et al 2000: 150). Bread can also be made from ground hazelnuts without mixing with other ingredients (McComb & Simpson 1999: 14), a process which Lightfoot (1777: 587) noted was sometimes undertaken in Scotland in the 18th century. In this period, hazelnut bread was thought to be particularly useful for consumption on long journeys (Milliken & Bridgewater 2004: 40), and it is interesting to speculate that hazelnut bread might have been used for a similar purpose in the Mesolithic.

Based on the shape and composition of possible roasting pits found at various Mesolithic sites in Europe, and hazelnut roasting experiments, it has been suggested that during the Mesolithic hazelnuts may have commonly been roasted in shallow pits lined and sealed with sand or gravel, on top of which a small fire was lit for a short period (illus 4; Perry 1999: 232; Score & Mithen 2000: 508; Hastie 2003b: 7). However, most ethnographic literature describes the use of hot coals for cooking rather than the direct use of fire (Turner & Kuhnlein 1982: 424–6; Pokotylo & Froese 1983: 130–1; Wandsnider 1997: 21–2; Hastie 2003b: 4). Considering this, it is possible that hazelnuts may commonly have been roasted by mixing the nuts into sand or earth and heated with hot charcoal from a fire that had already burned down (Holst 2010: 2874). This method, which was used to cook nuts and roots by the !Kung in South Africa (Yellen 1977: 143), leaves behind a shallow depression containing mixtures of ash, charcoal and sand (ibid: 87), similar to Mesolithic features containing abundant nutshell in Europe (Holst 2010: 2874). The depression in the ground results from the raking of the nuts, charcoal, ash and sand during cooking and was not a formal cooking pit (Yellen 1977: 87). Given that about 25% of hazelnuts may become charred during roasting (Score & Mithen 2000: 510), hazelnut roasting could have been a major source of carbonised nutshell on archaeological sites (illus 4). However, the potential absence of formal cooking pits for this process (Yellen 1977: 87) presents a problem for recognising roasting in the archaeological record.

There are several benefits of hazelnut roasting. Not only does hazelnut roasting improve flavour and digestibility, it also increases the ease of grinding for bread or cake-making and would have facilitated transportation by reducing the mass of the nuts up to 50% (Stahl 1989: 181; Mason 1996b: 1; Mithen 2000: 435; Score & Mithen 2000: 511; Mithen et al 2001: 228; Hastie 2003b: 5; Mears & Hillman 2007: 26–8; Holst 2010: 2874). Several authors have also proposed that roasting increases the storability of hazelnuts (Mithen et al 2001: 228; Hastie 2003b: 5;

Mears & Hillman 2007: 28; Holst 2010: 2874). However, Mason (1996b: 1) argues that roasting would not increase storability and ethnographic and historical descriptions state that hazelnuts should be dried rather than roasted for storage (Howes 1948: 184; Loewenfeld 1957: 40; Kuhnlein & Turner 1991: 16; Moerman 1998: 182). This is supported by modern commercial hazelnut roasting trials, which suggest that roasting at high temperatures actually reduces shelf life, unless the nuts are first heated at a lower temperature (Alamprese et al 2009). Also, trial storage experiments suggest that roasted hazelnuts may store less well in pits than unroasted nuts (Cunningham 2010).

Consequently, a further process that may have preserved hazelnut shell on Mesolithic sites is the drying of the nuts beside the fire for storage (Ebeling 1986: 209; Kuhnlein & Turner 1991: 16; Mithen 2000: 435). Drying hazelnuts prior to storage prevents them from going mouldy and once dried, they can be stored for at

Illus 4 Illustration of the hazelnut roasting process, conducted by the authors following the methodology proposed by Score and Mithen (2000): (a) shallow pit lined with sand and filled with hazelnuts; (b) pit covered with a shallow layer of sand; (c) small fire lit on top of the pit; (d) layer of charred hazelnuts at the top of the pit, after the removal of fire ashes and top layer of sand

least six months (Howes 1948: 185; McComb 2009: 229; Cunningham 2010). The smoke, as well as the heat from the fire may also have helped to prevent mould attack (Howes 1948: 27). A further benefit of drying is that it makes hazelnuts easier to dehusk compared to fresh nuts (Talalay et al 1984: 351). In continental Europe, nuts were traditionally sun-dried by laying the nuts out on trays a few inches deep during the day and frequently stirring them and then covering them at night (ibid). With constant hot weather this process took two to three days (ibid). Clearly this drying method would not have been suitable in the cooler/wetter climate of Scotland and it is probable that fire drying was necessary. Therefore, roasting and drying are both potential mechanisms for the charring of hazelnut shell on Mesolithic sites.

As in some regions of 20th-century Europe, the nuts would probably have been cracked individually on a stone or block of wood using a hammer stone or wooden baton (Howes 1948: 32). Experimentation with hammerstones and anvils of different shapes and sizes has shown that elongated pebble tools, like those found at Staosnaig, were particularly effective for hazelnut cracking (Score & Mithen 2000: 511). Experiments suggest that 125g of kernel per hour may be produced using this method (Talalay et al 1984). It is also possible that wooden nut-crackers were produced from the branches of hazel trees. Mabey (1997: 90) describes one such wooden nut-cracker made from hazel wood:

> I have seen a pair of these made by a Sussex hurdle-maker in the 1930s, which he used to carry when working in the coppices in autumn. After shaping a piece of straight wood with his knife, he soaked it, doubled it over, and then bound it tightly with a strip of split hazel until it dried out.

Hazelnuts may also have been cracked by pouring cold water over nuts heated by burning vegetation on top of them (Carruthers 2000: 414).

After cracking, or cooking/drying and then cracking, the hazelnut shells could also have become charred if they were deliberately thrown onto fires to dispose of the unwanted nutshell after nut consumption (Kubiak-Martens 1999: 123; McComb 2009: 227). Hazelnut shell may also have been deliberately kept for use as kindling or as a fuel source because hazelnut shell burns well and produces a hot flame (Munson et al 1971: 427; Mason 1996b: 2; Kubiak-Martens 1999: 123). Alternatively, considering the durability of nutshell (Mellars 1976b: 376), it may have become charred if a fire was lit on the soil surface in an area formerly used for nut cracking (Sievers & Wadley 2008).

Lesser celandine root tubers

Despite the fact that lesser celandine tubers (illus 5) have only been recovered from two sites in Mesolithic Scotland (Table 3), it is highly likely that they were used as food. At Staosnaig, Colonsay, over 400 lesser celandine root tubers and bulbils were recovered from a single pit context, together with nutshell radiocarbon dated to the Mesolithic. Considering the secure nature of the deposit, the lack of in-situ burning in the pit and the large number of small, fragile, charred lesser celandine remains present, it is unlikely that the root tubers accumulated naturally within the pit and so they were most likely deliberately deposited through human action (Mason & Hather 2000: 421; Mithen et al 2001: 230). This contention is supported by the discovery of charred lesser celandine tubers from samples taken during recent excavations of the old ground surface at Northton, Harris (Table 3).

Ethnographic and historic observations also support the idea that lesser celandine roots may have been collected for food in the Mesolithic. While lesser celandine is not native to North America, it has been introduced and modern hunter-gatherers have made use of the roots for food (Kuhnlein & Turner 1991: 317). The roots of several other members of the Ranunculaceae family were also traditionally

Illus 5 Illustration showing (a) lesser celandine growing in woods in spring; (b) lesser celandine growing in woods in October, showing that the plant is no longer visible above the ground. The roots are easily uncovered beneath leaves; (c) whole lesser celandine plant harvested in spring, showing root tubers and bulbils; (d) lesser celandine root tubers

consumed by North American hunter-gatherers (Gunther 1973: 30; Kuhnlein & Turner 1991: 318; Moerman 1998: 468–9). Lesser celandine roots have also been used historically as food in Scotland in times of famine (Darwin 1996: 145) and are collected for food today by modern foragers in Britain (Irving 2009: 73; Mears & Hillman 2007: 106). Though lesser celandine has traditionally been used as a cure for piles in Britain (Gerarde 1597: 669; Pierpoint Johnson 1862: 17; Ranson 1949: 39; Grigson 1975: 50; Grieve 1992: 181; Darwin 1996: 145; Milliken & Bridgewater 2004: 206), this tradition derived from the 15th and 16th century 'Doctrine of Signatures' (Ranson 1949: 16–17; Darwin 1996: 145), which linked the visual similarity of the root tubers to haemorrhoids, rather than originating from any medicinal effects of consuming the tubers (Pierpoint Johnson 1862: 17; Hogg & Johnson 1864: 115; Grieve 1992: 181; Dickson & Dickson 2000: 264). Having said this, considering that British Pharmacopoeia has reintroduced lesser celandine as a cure for piles, it is possible that despite the dubious origin of the cure, the plant does indeed provide effective treatment for this condition (Grieve 1992: 181; Dickson & Dickson 2000: 264; Mason & Hather 2000:

423). Therefore, the possibility that the roots were collected for medicinal purposes cannot be discounted, but it seems more likely that the root tubers were collected for food in Mesolithic Scotland.

The lesser celandine root tubers may have been harvested by uprooting by hand or using a pointed wooden digging stick, like those used by hunter-gatherers in North America and Canada (Kuhnlein & Turner 1991: 15). Alternatively, they may have been dug up using antler mattocks, like those found in the Scottish Mesolithic (Bonsall & Smith 1989; Smith 1989; Bonsall & Smith 1990; Zvelebil 1994: 55; Mears & Hillman 2007: 30), which, amongst other purposes, have been suggested to have functioned as digging tools (Saville 2004:200).

The two main situations in which lesser celandine roots could have become charred and preserved are during cooking prior to consumption and drying for storage. It is unlikely that lesser celandine roots would be consumed raw, because all *Ranunculus*/*Ficaria* species contain protoanemonin, a poisonous substance, which can be reduced or removed by cooking or drying (Forsyth 1968: 35; Frohne & Pfänder 1984: 309; Kuhnlein & Turner 1991: 231; Mason & Hather 2000: 422; Milliken & Bridgewater 2004: 32). However, Grieve (1992: 181) notes that lesser celandine has a low acridity compared to the other *Ranunculus*/*Ficaria* species and a small-scale study suggests that the protoanemonin is mostly concentrated in the flowers and stems rather than the roots and leaves (Bonora et al 1988). Considering this, together with the fact that the protoanemonin content can be reduced by cooking and that there is ethnographic evidence for the consumption of the roots of *Ranunculus* species (see above; Lightfoot 1777: 292), there is no reason to reject the idea that lesser celandine was eaten in the Mesolithic.

Roots have traditionally been cooked either by steaming in a pit over hot rocks under layers of vegetation and earth or by boiling (Lightfoot 1777: 292; Turner & Kuhnlein 1982: 424–6; Pokotylo & Froese 1983: 130–1; Kuhnlein & Turner 1991: 17; Mason & Hather 2000: 422; Mithen 2000: 433). They could also have been roasted (Irving 2009: 73), perhaps in the ashes of the fire or using hot charcoal mixed with sand (Yellen 1977: 143). As with nuts, roots and tubers can be stored for long periods once dried, and the root tubers may have been dried beside a hearth (Kuhnlein & Turner 1991: 16). Given that most of the root tubers/bulbils at Staosnaig and Northton were well preserved and were identifiable to species level, it is likely they were already dry prior to charring (Hather 1993: 22; 2000a: 46; Mason & Hather 2000: 417; Bishop 2013) or were charred by the drying process if they were slowly dried and left too long beside the heat (Mithen 2000: 438; Bishop 2013). Therefore, the lesser celandine tubers probably represent a stored dried product that was accidentally charred or tubers that were charred accidentally whilst being dried for storage.

Seaweed

Only one fragment of charred seaweed was present in the Mesolithic assemblages (Table 3). The fragment of possible knotted wrack (cf *Ascophyllum nodosum* (L.) Le Jolis) seaweed from Staosnaig probably represents a deliberately gathered foodstuff since all British seaweeds, except sea sorrels (*Desmarestia* sp.), are edible (Milliken & Bridgewater 2004: 52; Mears & Hillman 2007: 61) and it is improbable that it became accidentally charred and deposited within a pit outwith the immediate vicinity of the seashore. Knotted wrack is a common seaweed that is easily collectable, since it is abundant on rocks and boulders in the middle shore zone (Newton 1931: 220; Kosch et al 1963: 32). In Iceland and Greenland, knotted wrack seaweed was historically collected for food in times of famine (Hallsson 1964: 399; Aaronson 2000: 235), and though it does not have a history of human use in Britain and Europe, it has been much used as an animal fodder and fuel source (Hallsson

1964: 400; Chapman 1970: 69; Indergaard & Minsaas 1991: 23) and meal made from this species is now used as a health food (Indergaard & Minsaas 1991: 54; Vaughan & Geissler 1997: 194; Irving 2009: 363). Though seaweed can be burnt as a fuel (Fenton 1978: 206), the availability of wood in Mesolithic Scotland suggests that knotted wrack was more likely to have been collected for consumption than for use as a fuel. The seaweed fragment from Staosnaig may have been charred accidentally during cooking or drying for storage. Seaweeds are commonly cooked by frying, steaming, boiling or adding to soups and stews (Kuhnlein & Turner 1991: 27–33; Irving 2009: 362). Ethnographic descriptions show that hunter-gatherers have traditionally preserved seaweeds for future consumption by sun drying or drying on racks over fires (Kuhnlein & Turner 1991: 27–33). As with the lesser celandine tubers, the slow drying over a fire would seem the most likely method of preservation of moisture-rich seaweed in archaeological samples.

Fruits and berries

Despite considerable evidence for the consumption of hawthorns historically in Britain (Lightfoot 1777: 256; Pierpoint Johnson 1862: 98; Hedrick 1919: 198; Phillips 1983: 139; Mabey 1997: 215), as well as by hunter-gatherers in North America and Canada (Kuhnlein & Turner 1991: 236–7; Moerman 1998: 183), the collection of hawthorns for food by Mesolithic people in Scotland is open to question. Given that only single hawthorn stones have been recovered from two sites (Table 3), it is possible that they may have been transported to these sites by natural processes and there is also an element of doubt over whether they can be securely dated to the Mesolithic. However, considering their relatively high mass, natural deposition or bioturbation and redeposition is unlikely. Hawthorn berries have also been used historically in Britain as a cardiac tonic, a diuretic, and were also used to correct high or low blood pressure and cure sore throats (Grieve 1992: 385; Darwin 1996: 149); they also have numerous traditional hunter-gatherer medicinal uses (Moerman 1998: 183–4).

If the hawthorns were eaten in the Mesolithic, they may have been consumed raw (Kuhnlein & Turner 1991: 236–7; Moerman 1998: 183–4; Burrows 2005: 7; Tardío et al 2006: 67) or after roasting in the ashes of a fire (Kuhnlein & Turner 1991: 236). Hawthorns may also have been dried for storage (Ertuğ 2000: 176; Out 2009: 351), either whole or by first processing into cakes (Kuhnlein & Turner 1991: 236–7; Moerman 1998: 183–4; Mears & Hillman 2007: 216–17). North American hunter-gatherers traditionally preserved hawthorns by crushing, removing the skins and stones, pressing into cakes and drying by the fire (ibid). Thus, the charred hawthorn stones in the Mesolithic assemblages may represent the waste material deposited after consuming the hawthorns raw, or preparing them for storage, or they may have become charred accidentally during cooking or drying if conditions within the fire existed that would preserve the stone but not the fruit.

It is also questionable whether pears formed part of the Scottish Mesolithic diet. Stace (2010: 200) states that wild pear (*Pyrus pyraster* (L.) Burgsd.) is not native to Britain and Clapham et al (1987: 244) suggest that it was probably introduced. Both authors agree that Plymouth pear (*Pyrus cordata* Desv.) was probably native, but given that its current distribution is restricted to: '2 hedges near Plymouth' and '3 sites near Truro' (Stace 2010: 200), it is not clear if this species was ever native to Scotland. The difficulty of identifying if pear forms part of the natural vegetation of Scotland is further compounded by the fact that the wood and pollen of *Malus* and *Pyrus* species are indistinguishable (Out 2009: 352). Also, there is little ethnographic evidence for the use of wild pear in Britain and several authors have noted that it is small, hard, tasteless or inedible (Pierpoint Johnson 1862: 99; Mabey 1997: 200; Mears & Hillman 2007: 223). It is possible that drying makes wild pears palatable, since ethnobotanic records from Slovakia note that *Pyrus pyraster* (L.) Burgsd. was consumed after drying (Stoličná 2000: 201), but considering the questionable native status of wild pear and the fact that only one pear pip has been discovered (Table 3), it seems unlikely that it is a remnant of Mesolithic consumption.

On the other hand, the presence of large quantities of crab apple pips and fruit fragments at Staosnaig (Table 3) does suggest that crab apples were deliberately collected. Though the consumption of crab apples have been used historically to relieve burns, inflammations, spasms, sprains, bruises and cramps (Gerarde 1597: 1277–8; Lightfoot 1777: 258; Pierpoint Johnson 1862: 100; Grieve 1992: 46–7; Darwin 1996: 151), they have primarily been eaten for food in Britain (Hill 1941: 39; Grigson 1975: 193; Phillips 1983: 131; Grieve 1992: 45–9; Mabey 1997: 201; Mears & Hillman 2007: 222; Irving 2009: 296). Most fresh crab apples are very bitter and astringent and require cooking or drying to make them palatable (Lightfoot 1777: 258; Pierpoint Johnson 1862: 100; Grieve 1992: 46; Wiltshire 1995: 391; Mabey 1997: 201; Dickson & Dickson 2000: 247; Mears & Hillman 2007: 222). Indeed, Moerman (1998: 334) makes no reference to any North American hunter-gatherers who ate the native crab apple (*Malus sylvestris* (L.) Mill.) without drying or cooking. Crab apples can also be dried for future use (Helbaek 1952: 111; Renfrew 1973: 139; Moerman 1998: 334; Mears & Hillman 2007: 222) and could either be consumed dried or rehydrated after storage, since astringency is still reduced even when they are rehydrated (Wiltshire 1995: 394; Moerman 1998: 334). Considering the astringency of raw crab apples (Lightfoot 1777: 258) and the poor preservation of fresh crab apples during carbonisation (Helbaek 1952: 111; Carruthers 2000: 412), it is unlikely that the burnt fruit fragments represent apple core debris that was disposed of onto a fire after the fruit had been consumed in a fresh state. Therefore, it is probable that the crab apples from Staosnaig were charred accidentally whilst being dried or cooked by a fire before consumption or storage.

One method of preserving apples for storage, used by modern hunter-gatherer groups in North America, was to mash the fruits up, press them into small ‘cakes’ and dry them by the fire or in the sun (Moerman 1998: 334). Alternatively, they may have been cut into thin slices or halves and hung on twine to air dry (Ellison et al 1978: 172; Kohler-Schneider 2007: 215), or cut into halves or quarters to dry by the fire – as is evident from Neolithic/Bronze Age samples from Scotland, Switzerland, Austria and Denmark (Helbaek 1952; Jacomet et al 1989; Church 2002; Jacomet 2007: 243; Kohler-Schneider 2007: 212). Crab apples may also have been dried on a basketry griddle over hot embers or by having heated stones rolled over them (Wiltshire 1995: 392).

Edible seeds

Vetches/tares are the most probable wild seeds gathered for consumption in Mesolithic Scotland. Though these seeds are only identified to genera, most *Vicia* or *Lathyrus* species have edible seeds (Mears & Hillman 2007: 177–85; Irving 2009: 131). *Vicia* and *Lathyrus* species grow in pods, are easy to collect and open and, unlike many seeds, do not require dehusking or grinding prior to consumption. Though they are only present in very small quantities, the seeds of *Vicia* or *Lathyrus* species are present in three Scottish Mesolithic assemblages (Table 4), suggesting their presence may not have been merely accidental. Seeds of several wild native species of these plants were eaten historically in Britain, Holland, France and Sweden (Pierpoint Johnson 1862: 80; Hedrick 1919: 327, 592–3; Fenton 2000: 192) and are still collected by modern gatherers today in Britain (Phillips 1983: 95; Mears & Hillman 2007: 179–80; Irving 2009: 242, 231–6). Hunter-gatherers in North America have also extensively exploited *Vicia* and *Lathyrus* species for food (Ebeling 1986: 241; Kuhnlein & Turner 1991: 190, 192; Moerman 1998: 595–6) and many used an infusion of the roots or the whole plant for various medicinal purposes (Moerman 1998). However, the seeds are not noted by Gerarde (1597: 1053–4), Kuhnlein & Turner (1991), Moerman (1998) or Grieve (1992) as having medicinal properties.

Though the seeds can be eaten raw in small quantities (Phillips 1983: 95; Moerman 1998: 299; Mears & Hillman 2007: 179), they were probably cooked before consumption or soaked in water because the seeds of some *Vicia* and *Lathyrus* species are toxic if eaten raw in large quantities (Cooper & Johnson 1984: 146; Kuhnlein & Turner 1991: 192; Frohne & Pfänder 2005: 196, 213). Considering that most hunter-gatherer groups in North America boil or roast *Vicia* or *Lathyrus* species before eating them (Moerman 1998: 595–6), the seeds were probably charred accidentally during roasting because seeds prepared by boiling are unlikely to have been preserved in archaeobotanical assemblages (Minnis 1981: 149). Dried *Vicia* or *Lathyrus* pods/seeds can also be dried for storage (Moerman 1998: 595–6). The seeds of yellow-vetch (*Vicia lutea* L.; native to Britain) and common vetch (*Vicia sativa* ssp. *sativa*; not native to Britain) were historically added to soups and flour for breadmaking in France and Spain, and in Holland and France the seeds of bitter-vetch (*Lathyrus linifolius* (Reichard) Bässler; native to Britain) were roasted (Hedrick 1919: 327, 592–3; Tardío et al 2006: 56).

Fat-hen is also a likely Scottish Mesolithic dietary component. Though no more than 10 seeds were recovered from any individual site, its presence in three different archaeobotanical assemblages suggests deliberate collection rather than accidental charring (Table 4). Like *Vicia* and *Lathyrus* seeds, fat-hen is easy to harvest and process and can produce return rates similar to cultivated cereals (Stokes & Rowley-Conwy 2002; Mears & Hillman 2007: 166). The seeds can be easily stripped from the seed head and require only gentle rubbing and winnowing to remove the sepals (ibid). Fat-hen seeds have been eaten historically in Britain, Poland and Russia and by hunter-gatherers in North America, and concentrations have been recovered from the stomach contents of seven prehistoric North-West European bog bodies (Hedrick 1919: 160; Grigson 1975: 104; Ebeling 1986: 146; Kuhnlein & Turner 1991: 152; Grieve 1992: 366; Moerman 1998: 154–5; Burrows 2005: 34; Behre 2008: 68). Though the leaves, stems and roots have some medicinal uses, the seeds are not noted by Gerarde (1597: 259), Kuhnlein & Turner (1991), Moerman (1998: 154) or Grieve (1992) to have been used as a drug. Ethnographic evidence from North America suggests that the seeds would have been processed by grinding into a mush or by parching and then grinding into flour to make bread, or dried for future use (Kuhnlein & Turner 1991: 152; Moerman 1998: 154–5). Therefore, the most likely activities that would result in the carbonisation of fat-hen seeds in archaeological assemblages are parching, cooking to make bread or drying for storage.

The seeds of the other edible species are less certain Mesolithic foodstuffs (Table 4). Though there is either ethnographic, historical or contemporary evidence for human consumption of the seeds of black bindweed (Renfrew 1973: 182; Darwin 1996: 139; Mears & Hillman 2007: 260), charlock (Milliken & Bridgewater 2004: 37), corn spurrey (Pierpoint Johnson 1862: 53; Darwin 1996: 94; Milliken & Bridgewater 2004: 37; Irving 2009: 246), knotgrass (Mears & Hillman 2007: 259; Irving 2009: 176) and ribwort plantain (Mears & Hillman 2007: 288; Irving 2009: 250), the seeds of these species are only present in low frequencies at one or two sites, and they could easily have arrived on each site as a result of non-anthropogenic processes. All of these species are common agricultural weeds and indicators of disturbed ground, which would have been found growing around human occupation areas (Long 1929: 104; Clapham et al 1987; Stace 2010). There are also several seeds that come from genera that include several species with edible seeds (Table 4), such as the docks (*Rumex crispus* L., *Rumex maritimus* L.)

(Moerman 1998: 498), oraches (nine *Atriplex* sp. listed, but none native to the UK) (ibid: 114–17) and sedges (multiple native edible *Carex* sp.) (Kuhnlein & Turner 1991: 76; Moerman 1998: 138; Mears & Hillman 2007: 324), but since not all species in these genera are known to be edible, human collection is uncertain. If eaten, the seeds of all of these plants would have been processed by drying and parching before being ground down into flour, and either eaten raw with water or boiled into a mush or baked into bread (Moerman 1998; Anderson 2006: 260–1). If these seeds were deposited on archaeological sites through human action then they were probably charred accidentally during parching, drying or cooking.

Edible shoots, roots and leaves

The seeds from a number of plants with edible leaves, shoots, roots and stems were present in low frequencies in the Mesolithic assemblages (see Table 5 and Appendix 1 for references). The frequency of the references in Table 5 gives an indication of the strength of the supporting evidence for the edibility of these plant components. As previously noted, several of these seed identifications (eg *Rumex* sp., *Atriplex* sp., *Carex* sp., *Ranunculus* sp., *Eleocharis* sp., *Viola* sp.) are only to genus level and so it is not certain whether they are definitely from the edible species in these genera. Also, the seeds of plants that were gathered for their leaves, shoots, stems or roots are highly unlikely to be preserved in archaeobotanical assemblages. Leaves, shoots and stems would have been harvested and eaten before the plants flowered and set seed whilst the plants are young and soft (Hill 1941: 11; Cameron 1977: 56; Pieroni 2005: 29; Behre 2008: 71) and the roots would have been gathered after flowering (Cameron 1977: 56). Therefore, while it is possible that all of the plants listed in Table 5 were eaten in Mesolithic Scotland, the seeds were most probably deposited by natural processes or as a result of deliberate seed collection for consumption or medicines.

Poisonous and inedible plants

Small numbers of seeds from poisonous or inedible plants were also recovered (Table 6). The latex that exudes from the stems of the sun spurge causes inflammation to the skin when touched and consumption of the plant can cause inflammation of the mouth and throat, gastroenteritis, vomiting and diarrhoea (Forsyth 1968: 74; Cooper & Johnson 1984: 117; Frohne & Pfänder 2005: 190–1). The seeds and bulbs of the bluebell are also poisonous to humans (Cooper & Johnson 1984: 169–70; Grieve 1992: 424). In addition, several taxa – cf wood-rush family, cf slender naiad, annual knawel and branched bur-reed – were not recorded as edible or poisonous in any of the ethnobotanical, historic or modern practical plant collection references consulted (see Appendix 1). Considering that 44 different references were consulted (Appendix 1), it seems unlikely that these species would have been important sources of food. The leaves and seeds of several species in the goosefoot (Chenopodiaceae) and grass (Poaceae) families are also edible, but without identification to genus or species this is highly speculative and so the seeds of these species were listed in Table 6 together with the inedible plants. The presence of this poisonous and non-edible material highlights the fact that at least some of the seeds recovered from Mesolithic sites were naturally rather than anthropogenically deposited.

INTENSIVE PLANT USE IN THE SCOTTISH MESOLITHIC?

INTENSIVE PLANT USE IN MESOLITHIC HUNTER-GATHERER ECONOMIES

In hunter-gatherer societies utilising plants intensively, Zvelebil (1994: 37) proposed that ‘people would be expected to engage in the conservation of their food resources, in the development of specialised tool kits for plant processing, and in the storage of plant foods’. As part of such a strategy, important

TABLE 6
Inedible or poisonous species and seed identifications at too high a taxonomic level to be certain of edibility. Numbers refer to numerical counts of plant components. Those marked with * are known to be poisonous, those marked with † are not known to have edible seeds and those marked ** are identifications to family level only

Site	*Period*	*Annual knawel seed †*	*Bluebell seed **	*Branched bur-reed seed †*	*Grass family seed ***	*Goosefoot family seed ***	*Slender naiad fruit †*	*Sun spurge seed **	*Violet fruit †*	*Wood-rush family seed †*
Littlehill Bridge	LMI							P		
Morton B	LMII	1								
Northton 2001	LMI				2					
Skilmafilly	LMII					1				
Staosnaig F24	M		3?	1			1?			1?
Upper Largie	LMII				1					
Warren Field (Pit 5)	M								1	

resources, which were only seasonally available, such as fruits and nuts, would have been deliberately targeted for large-scale gathering. In order to maximise the use of plants gathered on a large scale and to prevent wastage of surplus, storage or feasting would have been undertaken. The storage of plants gathered on a large scale would have helped to minimise risk against seasonal and inter-annual food shortages, reduce transportation difficulties between gathering/processing sites and more permanent settlements, and would have provided material for exchange and social display/control of resources (Rowley-Conwy & Zvelebil 1989; Mithen 2000: 435; Bonsall 2008: 262; Cunningham 2010: 24; 2011: 137). The storage of foods, such as fruits, would also have been a key mechanism of preventing seasonal nutritional deficiencies, by providing vitamins that were unavailable in winter. For instance, the Inuit in west and north-west Alaska traditionally gathered berries in large quantities in autumn for winter consumption (Anderson et al 1998: 231; Burch 1998: 208). Though conducted for social and political reasons, feasting – the communal consumption of food, often on a large scale – is another way of dealing with surplus gathered foods (Hayden 2001; Milner 2009: 79).

Particular plants may also have been targeted for storage on a much smaller scale. Small-scale storage would have been an important method of creating portable high-energy foods for transportation or for storage in pits along routes between specialised activity sites and would have aided mobility (Kuhnlein & Turner 1991: 16; Cunningham 2010: 25; 2011: 3). For example, dried fruits and berries would have been a valuable food source for mobile hunter-gatherers since they have a high calorific content (USDA 2014), and once dried, are easily transportable because of their low mass and volume (Kuhnlein & Turner 1991: 16; Cunningham 2011: 140). Small-scale storage of surplus may also have taken place in temporary camps, to be utilised when the sites were reoccupied at a future date, or for short-term storage during the occupation of a temporary settlement (Rowley-Conwy & Zvelebil 1989: 48; Cunningham 2011: 3). This would have been an important way of ensuring that food was immediately available on the reoccupation of a site and of providing a food supply whilst obtaining further resources (ibid).

RECOGNISING INTENSIVE PLANT USE IN THE ARCHAEOLOGICAL RECORD

Intensive plant use can be recognised in the archaeobotanical record by identifying sites with high-density plant assemblages, which provide evidence for the large-scale collection and processing of particular plants. High-density plant deposits can be created in a number of ways:

1. Accidental/deliberate charring of products/waste products during the large-scale processing or drying/roasting for storage.
2. Accidental charring of products/waste products during the large-scale processing or cooking for feasting.
3. Accidental charring of an in-situ stored product or preservation of an in situ stored product in waterlogged conditions.

In the archaeobotanical record, feasting deposits would be indistinguishable from high-density plant deposits created during processing for storage. Both types of deposit may be dominated by large concentrations of products or waste products. However, it should be noted that though feasting involving plants occasionally occurs, most ethnographic examples of feasting relate to the increased consumption of meat or fish rather than plant foods (Hayden 2001: 41; Rowley-Conwy & Owen 2011: 327). Therefore, high-density plant deposits are more likely to represent the preparation of plants for storage rather than feasting remnants.

Where preservation conditions were favourable, samples recovered from storage contexts should be dominated by plant products, though waste products may also be present if the plant did not require full processing before drying for storage (cf Hillman 1981). Unfortunately, direct evidence for storage in the Mesolithic is extremely rare in the archaeological record. There is little evidence for storage facilities in Mesolithic Britain because pottery is absent and organic containers do not survive in non-waterlogged conditions (Cunningham 2011: 135). It is also difficult to identify plant storage pits because they can be used for multiple purposes unrelated to storage and the stored contents of pits would only come in contact with fire in exceptional circumstances (Cunningham 2010: 10; 2011: 141). Plant stores can be preserved in waterlogged deposits, but unfortunately Mesolithic waterlogged sites are rare in Britain. Furthermore, considering that most Mesolithic structures were probably fairly small and short-lived (Wickham-Jones 2004a) compared to later prehistoric structures, the storage of plant products in the roofs of structures close to domestic hearths would be less frequent than in later periods (cf Rowley-Conwy 2000: 44–7; cf Jones & Rowley-Conwy 2007: 401 on Neolithic structures). Therefore, there would be much less opportunity for the accidental charring of plant stores in the Mesolithic than in later prehistory.

The small-scale storage of plant foods is even more difficult to recognise because high-density plant deposits would not be created during preparation for storage. It is possible though, to infer the existence of small-scale storage by considering the taphonomy of the preserved plant remains. Small-scale storage in hunter-gatherer societies is best recognised through the presence of highly seasonal resources on a large number of sites in a study-area, because without storage, all the sites where a particular resource is identified would have been occupied in the same season.

The identification of small quantities of moisture-rich foods, such as fruits, roots/tubers and seaweed, in archaeobotanical assemblages also provides evidence of drying for small-scale storage. As previously discussed, the preservation of roots/tubers and seaweed is extremely poor if they are charred when fresh and they are most likely to be identifiable to species if they have been dried prior to charring (Hather 1993: 22; 2000a: 417; Mason & Hather 2000: 417).

ARCHAEOLOGICAL EVIDENCE FOR INTENSIVE PLANT USE IN MESOLITHIC SCOTLAND

There are several sites which had notably large concentrations of hazelnut shell: East Barns in East Lothian, Weston Farm near Newbigging, Cramond in Edinburgh and Staosnaig on Colonsay (Table 3). More than 234g of hazelnut shell was recovered at East Barns, but the density of nutshell across the site was not particularly high (*c* 1g per litre of soil) because the nutshell was recovered from a range of contexts from across the site including pits, an occupation horizon and the fill of the structure. The largest sample of nutshell contained 25g (*c* 2g per litre of soil). At Weston Farm, a concentration of hazelnut shell fragments was deposited in a shallow pit (834 fragments in *c* 25 litres of soil), together with burnt bone, hazel and willow charcoal and lithics. The nutshell from Cramond was present in most samples across the site and large quantities of highly fragmented hazelnut shells were found concentrated within two shallow pits, together with small amounts of charcoal, burnt bone and lithic material (density information not available). It is difficult to assess the significance of these results because of the different quantification methods used: the mass was measured at East Barns, fragments counted at Weston Farm and a semi-quantative abundance scale was used for the Cramond assemblage. It is also uncertain how common such concentrations of nutshell were in Mesolithic Scotland, because hazelnut shell has not been fully quantified on most other sites and sample volumes have rarely been published.

However, considering the highly fragmented nature of the nutshell and the absence of hazelnut kernel from all three of these assemblages, there is no evidence that any of the pits contained the remnants of hazelnut stores burnt in situ. It is possible that the nutshell from Weston Farm and Cramond was derived from the pit roasting of hazelnuts, especially considering that the shallow morphology of the pits is similar to roasting pits identified at other sites (Hastie 2003b: 7; Perry 1999: 232; Score & Mithen 2000: 508; Holst 2010). The fragmented nature of the nutshell may also be suggestive of roasting (Score & Mithen 2000; Hastie 2003b: 7). Considering the presence of the other environmental and artefactual material in these pits, it is also possible that the nutshell represents discarded waste material that was deliberately deposited or naturally accumulated in the pits from the surrounding deposits (Miksicek 1987: 226), perhaps after roasting or drying for storage. Overall, all that can be said is that the quantities of nutshell recovered from these three sites clearly attest to the importance of hazelnuts in the economy, but without further analysis of these assemblages, none provides indisputable evidence of the large-scale collection, processing or storage of hazelnuts.

On the other hand, the assemblage from Staosnaig F24 provides clear evidence of intensive plant use. At this site, a large pit contained the fragmented nutshells from an estimated 30,000–40,000 whole hazelnuts, as well as one whole hazelnut kernel and several fragments, 414 lesser celandine tubers/bulbils, several charred crab apples, occasional carbonised seeds, sparse charcoal fragments and abundant lithics. There are several possible processes that could have resulted in the charring and deposition of the hazelnut shell in this feature. Mithen (2000: 434) argues that the plant remains from F24 were not carbonised within the pit itself, due to a lack of clear evidence for in situ burning and the infrequent nature of wood charcoal within the pit. Considering this, together with the rarity of whole hazelnuts or nut kernels in the deposits, there is no evidence that the hazelnuts represent an accidentally burnt store. Mithen (2000: 434) proposes that the hazelnuts were accidentally carbonised whilst being roasted within the smaller pit features surrounding F24 and were deposited within F24 as a means of rubbish disposal. Given the short duration of deposition within the pit (ibid), the large-quantity of nutshell and the fact that raw hazelnuts are indigestible when consumed in large quantities (Gerarde 1597: 1251; Mears & Hillman 2007: 26), it is improbable that the nuts would have been eaten raw without cooking. It therefore seems unlikely that the nutshell represents the accidental/deliberate use of cracked nutshells as a fuel after the consumption of the raw nuts, though it is also possible that the nuts were charred accidentally during drying for storage rather than during roasting. Whatever the mechanism of preservation at Staosnaig, hazelnut collection and processing had clearly taken place on a substantial scale.

Whilst clear evidence for large-scale hazelnut exploitation is so far limited to a single site in Scotland, a number of particularly notable concentrations of nutshell have been recovered from other areas of North-West Europe (Mellars 1976b: 376; Zvelebil 1994: 41; Cotton 2007; Holst 2010; Warren et al 2014: 5). For example, at the site of Howick in North-East England, more than 200,000 charred hazelnut fragments were recovered from a range of contexts within a hut structure, with particularly dense concentrations associated with some features (Cotton 2007). Approximately 42,000 hazelnut shell fragments were recovered from multiple phases of the central hearth, suggesting that hazelnuts were routinely and intensively used (ibid). There is also evidence that in-situ nut roasting took place within the structure: a pit with a heat-effected lining and fill contained approximately 5,600 charred hazelnut fragments (ibid). Similarly at Duvensee, in Northern Germany, a series of hearths contained thick layers of sand and charred hazelnut shells (comprising over 33,600 whole hazelnuts), which are highly suggestive of large-scale hazelnut roasting (Holst 2010). This evidence supports the idea that large-scale hazelnut collection and processing for consumption was common in Mesolithic North-West Europe and may have been more widespread in Scotland than has so far been identified in the archaeological record.

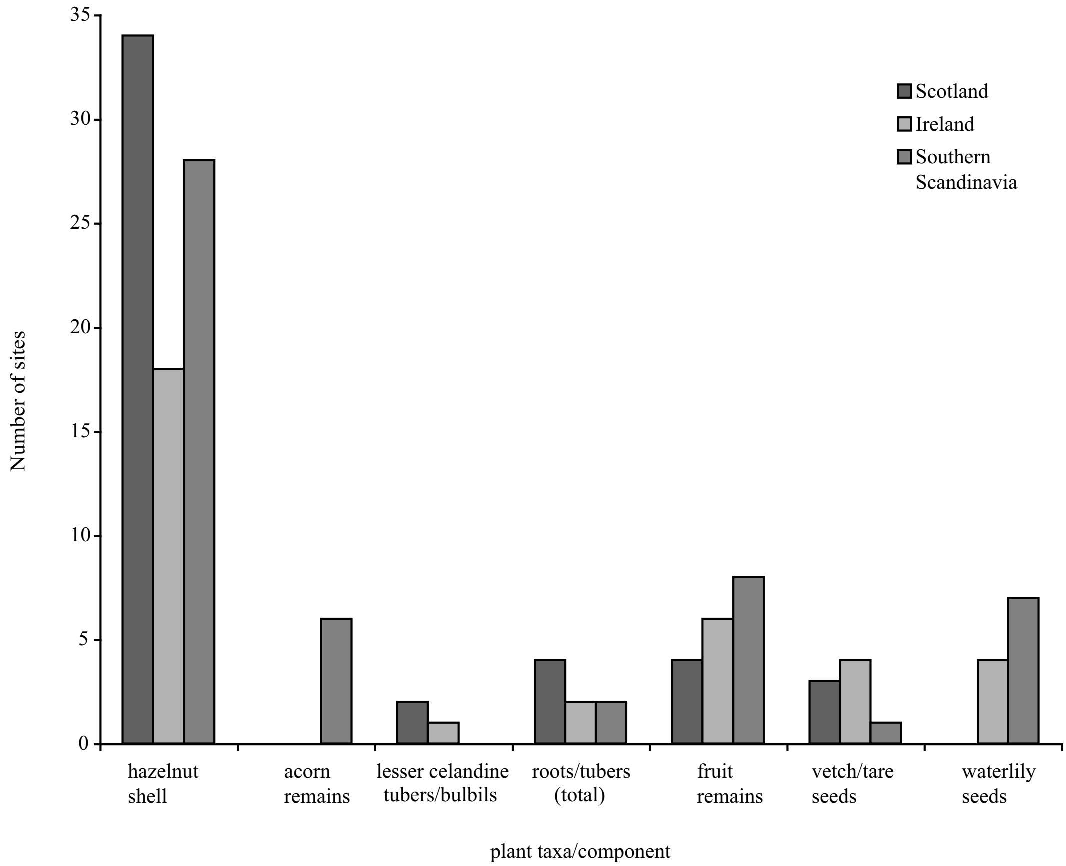
Similarly, there are no direct examples of in situ burnt/waterlogged Mesolithic hazelnut stores in Scotland, but examples are known from the Irish Mesolithic, suggesting that deposits of this kind might survive in Scotland where favourable conditions exist. For instance, at Lough Boora, Ireland, approximately 500 uncarbonised whole hazelnuts were recovered from a shallow feature interpreted as a storage pit (McComb & Simpson 1999).

In the absence of direct evidence for storage, the existence of plant storage in Mesolithic Scotland can be inferred in a number of ways. Firstly, considering the seasonality of hazelnut production and short window of time (usually two to eight weeks) from September to October when hazelnuts are available for collection (Hill 1941: 41; Howes 1948: 184; Loewenfeld 1957: 40; Mabey 2001: 122; Holst 2010: 2878), it is clear that the gathering of large quantities of hazelnuts, such as at Staosnaig, would have required a short, intense period of gathering, drying/roasting and ultimately storage to maximise the harvest and to prevent wastage (McComb & Simpson 1999: 7; McComb 2009: 228; Holst 2010; Cunningham 2011: 142). Secondly, the ubiquity of hazelnuts on Mesolithic sites suggests that hazelnut storage was a common practice. If hazelnuts are purely indicators of seasonal collection in the autumn, then 39 of the 57 site blocks discussed in the review would have been occupied in the autumn or several seasons including the autumn. More probably, some of the sites were occupied in the autumn, others for repeated visits or periods of time over several seasons and others would have been visited at other periods during the course of the year. It is highly improbable that all of the Mesolithic sites where hazelnuts were recovered were occupied in September/October, during the short period when hazelnuts would have been available for exploitation (Dark 2004; McComb 2009: 230). Thirdly, as previously discussed, the most likely mechanism for the preservation of the moisture-rich lesser celandine root tubers/bulbils, crab apple and seaweed remains at Staosnaig and Northton was by charring during drying for storage. Thus, despite the limited quantity of archaeobotanical material currently available, there is some evidence that plants were exploited in a systematic and intensive manner in Mesolithic Scotland.

HAZELNUTS: A STAPLE FOOD IN THE MESOLITHIC?

The abundance of hazel in the environment and hazelnut shell on Mesolithic sites in North-West Europe, has led many to suggest that hazelnuts may have been a staple food source in the Mesolithic (Mellars 1976b: 376; Zvelebil 1994: 62; Dickson & Dickson 2000: 257; Holst 2010; Regnell 2012). In addition to the 34 Scottish sites included in this review, hazelnuts have been recovered from at least 20 English and Welsh sites (Mellars 1976b: 376; Zvelebil 1994; Cotton 2007; Dark 2007), 18 Irish sites (Warren et al 2014), 28 Southern Scandinavian sites (Zvelebil 1994; Robinson 2007) and two Northern German sites (Zvelebil 1994) of Mesolithic date (illus 6). Syntheses of Neolithic archaeobotanical assemblages in North-West Europe (Moffett et al 1989; Jones & Rowley-Conwy 2007; Robinson 2007; Bishop et al 2009; Kirleis et al 2012; McClatchie et al in press) have also highlighted the importance of hazelnuts within Neolithic economies in the region, showing a degree of continuity of economic practice from the Mesolithic–Neolithic.

Hazelnuts would have been important resources for hunter-gatherers, since they are high in energy and fat, containing approximately



Illus 6 Comparison of the plant macrofossil records from Mesolithic sites in Scotland (Table 3), Ireland (Warren et al 2014) and Scandinavia (Robinson 2007)

400kcal per 100g when fresh (Howes 1948: 3) or about 650kcal per 100g when dried (Holland et al 1991: 314) and could have provided sufficient calories for use as a staple food (Loewenfeld 1957: 36; Jarman et al 1982: 68). As discussed previously, they can also be easily collected in large quantities and stored over the winter, providing a reliable winter food source (Howes 1948: 184; Mellars 1976b: 376; McComb & Simpson 1999: 3; Carruthers 2000: 415; Dickson & Dickson 2000: 258). Hazelnuts are also a much more predictable resource and require less energy to process than meat (Jacobi 1978: 82–3; Hastie 2003b: 4).

Though it is difficult to assess the productivity of hazel in the Mesolithic, the widespread availability of hazel within the environment (Tipping 1994; 2004) and the existence of unshaded, hazel-dominated woodlands in many areas would have provided the ideal environment for hazel to flower and provide abundant nuts for exploitation (Dickson & Dickson 2000: 258; Holst 2010: 2876). Using estimates of the calorific yield produced from modern commercial hazel orchards in Britain and the frequency of hazel in early Holocene pollen diagrams in England, Jacobi (1978: 82) has suggested that a 0.75–1 mile square area of woodland would have supplied enough hazelnuts for four families for 25% of their diet for four months. More useful figures are available from hazelnut calorific return rate experiments, which show that processing time rather than harvesting time is the major factor influencing return rates (Talalay et al 1984: 356; Holst 2010: 2877). Experiments with the American hazelnut (*Corylus americana* Walter), suggest that a single person working for eight hours (collecting and cracking nuts) could produce the necessary calories (0.087kg/5,920kcal nutmeat per hour) for approximately three adults for one day or a single adult for three days (Talalay et al 1984: 356). Holst (2010: 2877–8) estimates that approximately '950 storable nuts (0.9kg nutmeat, 5,130kcal per hour) could be obtained per person per hour, equivalent to about 7,600 nuts (6.8kg nutmeat, 40,800kcal) per day', or allowing for a 30% loss rate, '4.8kg nutmeat (28,800kcal) per person per day' and that an individual could produce 44% of the required annual energy in the 14-day hazelnut season. As Holst (2010: 2878) points out, these return rates greatly exceed estimates produced for wild cereals – *c* 900–1,200kcal per hour – and acorn return rates – *c* 850–1,350kcal per hour (Barlow & Heck 2002) – showing the potential importance of hazelnuts in the diet.

However, there are several factors that could potentially have limited the use of hazelnuts as a staple food. Firstly, hazelnut productivity varies inter-annually (Cunningham 2011: 142), especially with cold and wet weather in April and May during pollination (Mason 1996a: 2). Secondly, competition with other animals would have restricted hazelnut yields and reduced the reliability of this resource (McCullagh 1989b: 43). Though the full potential impact of red squirrels on hazelnut yields in post-glacial forests is uncertain, modern experiments and observations suggest that grey (non-native) squirrels have a major impact on hazelnut yields since they consume the nuts before they are ripe (Howes 1948: 179; Talalay et al 1984: 343; Mason 1996b: 3; McComb & Simpson 1999; Carruthers 2000: 414; Rackham 2003: 210; Irving 2009: 64; McComb 2009). It should also be remembered that the values commonly quoted in support of the productivity of hazel relate to modern planted woodlands (ibid) or incomparable ecological environments, such as North America (Holst 2010, table 2), and there is no detailed data available on the productivety of native hazel in unmanaged hazel-dominated woodlands. Consequently, estimates of hazelnut yields in the Mesolithic should be treated with caution.

Having said this, considering the abundance of hazel in the Scottish Mesolithic environment (Birks 1989; Tipping 1994; Edwards & Whittington 2003), even allowing for the exploitation of hazel by other nucivorous species, it seems likely that hazelnut availability would have exceeded the capacity of the available labour for nut harvesting rather than vice versa (Holst 2010: 2878). It should also be noted that hazelnut storage would have been an important way of minimising shortages during years with poor harvests (cf Rowley-Conwy & Zvelebil 1989) and that modern commercial nut growers shoot large numbers of grey squirrels to protect their hazel trees (Mason 1996a: 2). Consequently, it seems probable that during the short, intense hazelnut gathering season in September/October, specialised hazelnut processing camps would have been established in the vicinity of particularly productive hazel woodland areas to protect the nuts from other nucivorous species and to dry the nuts for storage (McComb 2009: 228; Holst 2010: 2878). Such camps could have been occupied throughout the winter to make use of the stored nuts, as well as other plant resources gathered for winter storage (Clarke 1976: 474). Therefore, given the ubiquity of hazelnut shell on Scottish Mesolithic sites, their availability, calorific properties and storability, it is clear that hazelnuts would have been a key aspect of the Mesolithic diet.

JUST A HAZELNUT BASED PLANT ECONOMY?

The contribution of hazelnuts to Mesolithic plant subsistence strategies should not be over-estimated. Though only recovered in very small quantities, the recovery of a range of edible fruits (hawthorn, crab apple and possibly pear) and seeds (eg fat-hen and vetch/tare) in Scottish Mesolithic assemblages, and the presence of lesser celandine tubers at Staosnaig and Northton, hints at the potential contribution of these species to the Scottish Mesolithic diet. The presence of these species on other Mesolithic sites in North-West Europe also provides supporting evidence for the exploitation of these resources by hunter-gatherers in Mesolithic Scotland. Charred hawthorn stones were present in small quantities at Westward Ho!, England (Vaughan 1987), and at Ringkloster, Denmark, and uncharred hawthorn fruitstones were abundant in waterlogged samples from three Scandinavian sites (Robinson 2007), perhaps indicating intentional gathering. Possible carbonised crab apple remains have also been recovered from Goldcliff, Wales (Dark 2007), and from several Irish sites (Warren et al 2014) and uncarbonised crab apple seeds were also present in waterlogged samples from Tybrid Vig, Denmark (Robinson 2007). Moderate concentrations of carbonised and uncarbonised fat-hen seeds have been reported from three sites in Scandinavia and carbonised *Vicia/Lathyrus* seeds from four Irish sites and one Scandinavian site (illus 6; Robinson 2007; Warren et al 2014). Charred lesser celandine tubers are absent from Southern British Mesolithic assemblages, but they are present in several Mesolithic and Neolithic assemblages in North-West Europe (eg Robinson & Kempfner 1987; Bakels 1988: 159; Fairbairn 1999; Out 2009: 357–8; Warren et al 2014).

In addition to these potential foodstuffs, it is also likely that Scottish Mesolithic hunter-gatherers utilised a wide diversity of other wild plants, many of which are virtually archaeologically invisible. Several authors have emphasised the wide variety of resources exploited by Mesolithic hunter-gatherers, and have seen the increased exploitation of nuts in the Mesolithic as a part of a diversified subsistence strategy (Clarke 1976: 475–6; Price 1989: 48). Clarke (1976: 464) suggests that there were between 250–450 edible plant species in temperate deciduous woodlands in Europe and ethnographic evidence from North America and Canada indicates that temperate hunter-gatherers usually exploit a wide range of plant species, with at least 1,649 species in North America and 550 species in Canada known to have been exploited for food (Kuhnlein & Turner 1991: 10; Moerman 1998: 15). Indeed, Anderson (2006: 242) estimates that between 60–70% of the diet of most tribes in California consisted of plants. Despite Keeley's (1992) prediction that hunter-gatherer plant use declines in higher latitude regions where plants are more seasonal, there is considerable historic and archaeobotanical evidence for the importance of wild plants in the diet in temperate parts of Europe and Asia. Archaeobotanical evidence from Abu Hureyra in Syria, shows that in the Epipalaeolithic hunter-gatherers exploited over 250 wild plants species for food (Hillman 2000: 397). Furthermore, Eurasian countries with detailed ethnobotanical and historic records of plant use indicate wild plants were extensively and routinely used for food historically, even in agricultural societies, and were not merely utilised in times of famine. For instance, across Spain, 419 edible plants have been recorded as being used historically and by contemporary people, of which 206 species were wild vegetables (Tardío et al 2006: 33; Tardío 2010: 214). Indeed, in contemporary Eurasia, ethnobotanical research shows that even today between 48–143 species (48 recorded for Italy, 59 for Portugal, 84–143 for different regions of Turkey) are recognised as food plants by older inhabitants in certain areas (Ertuğ 2009: 65; Carvalho & Morales 2010: 153; Nebel & Heinrich 2010: 176). In Britain, Lightfoot (1777) listed about 80 edible plants in Scotland, and contemporary plant gathering guides in Britain list over 250 edible plants (Irving 2009).

Archaeobotanical evidence from other areas of North-West Europe also highlights that a range of other fruits, nuts and seeds were most probably exploited by Mesolithic hunter-gatherers in Scotland: elder (*Sambucus nigra* L.), sloe (*Prunus spinosa* L.), crowberry (*Empetrum nigrum* L.) and guelder-rose (*Viburnum opulus* L.) have all been recovered from assemblages in England, Wales and Ireland (Vaughan 1987; Dark 2007; Warren et al 2014) and carbonised/waterlogged remains of sloe (*Prunus spinosa* L.), wild strawberry (*Fragaria vesca* L.), rosehip (*Rosa* sp.), raspberry/blackberry (*Rubus idaeus* L./*Rubus fruticosus* L. agg.), dewberry (*Rubus caesius* L.) and guelder-rose (*Viburnum opulus* L.) are represented in Scandinavian Mesolithic assemblages (Robinson 2007).

Two other particularly notable absences from Scottish Mesolithic assemblages are waterlily seeds and acorns. Yellow and white water-lily (*Nuphar lutea* (L.) Sm./*Nymphaea alba* L.) seeds have been recovered in large quantities from several Irish and Scandinavian sites and concentrations of charred/waterlogged acorns (*Quercus* sp.) from several Scandinavian sites (illus 6; Zvelebil 1994; Robinson 2007; Warren et al 2014). The edible components of these plants have a high calorific content (approximately 4,300–5,000kcal/kg for acorns and 3,610kcal/kg for yellow waterlily seeds (Barlow & Heck 2002; USDA 2014)) and there is substantial ethnographic evidence for the large-scale exploitation of these plants by modern hunter-gatherers in North America (Moerman 1998). Consequently, these plants were potentially significant within Mesolithic hunter-gatherer economies in Scotland.

Similarly, edible roots and tubers have rarely been recovered from Scottish Mesolithic sites, but they may have formed an important component of the Mesolithic diet because of their predictability, storability, high carbohydrate content and year-round availability (Clarke 1976: 476; King 1994: 187; Hardy 2007: 6). In the highly forested environment of Mesolithic Scotland, edible roots/tubers would also have been more readily available than annual seeds (Clarke 1976: 476) and would probably have provided the major carbohydrate component of the diet, as in most modern hunter-gatherer societies today (Vincent 1985: 132). Moreover, ethnographic research shows that the energy and time expended was much greater for the gathering and processing of seeds than for tubers (Hardy 2007: 5), suggesting that tubers may have had a greater importance in hunter-gatherer diets than seeds. Humans also faced much less competition with other animals for roots/tuber exploitation (Hardy 2007: 6) than for hazelnut collection, because roots and tubers grow underground and are more difficult for other animals to access.

The dearth of edible tubers/roots recovered from archaeological samples can be explained by the fact that charred roots/tubers are rarely recognised by archaeobotanists, because they cannot be identified using conventional archaeobotanical methods, requiring specialist skills and an SEM for full identification (Mason et al 1994: 55; Zvelebil 1994: 48; Hather & Mason 2002: 2). Roots and tubers have been frequently found in European assemblages which have been analysed appropriately (Hather & Mason 2002: 5; Mason et al 2002: 195). For example, the edible tubers/bulbs/roots of pignut (*Conopodium majus* (Gouan) Loret), ramsons/wild garlic (*Allium* cf *ursinum* L.) and possible sea beet (*Beta vulgaris* spp. *maritima* (L.) Arcang.) have been recovered from the Danish Mesolithic sites of Tybrind Vig and Halsskov (Kubiak-Martens 1999; 2002). The presence of vesicular material and stems/rhizomes at four Scottish Mesolithic sites, suggests that unidentified edible roots/rhizomes/tubers may have been present at several sites.

Furthermore, many edible plants may not have been calorifically important components of the plant economy, but they may have played an essential nutritional role in the diet (Etkin 1994: 2–3). In particular, the importance of edible leaves has probably been severely underestimated in the Mesolithic diet. Leafy green plants were probably important dietary components for Mesolithic hunter-gatherers since they are easy to collect and are high in vitamins and minerals (King 1994: 187). Since they are usually eaten in a raw state at the point of collection and are extremely fragile, leaves are not preserved in archaeobotanical assemblages (King 1994: 189; Ertuğ 2009: 64).

In part, the numerical frequency of hazelnuts relative to other plant remains in Mesolithic assemblages probably relates to the fact that nutshell is a waste product of consumption. Hazelnut shells would be deliberately discarded – often onto domestic fires – or used as a fuel, whereas tubers, seaweed, fruits and seeds are likely to have been consumed and would only be charred occasionally during cooking or processing accidents (Munson et al 1971: 427; Jones 2000: 80; Mithen 2000: 437; Pearsall 2000: 204; Jones & Rowley-Conwy 2007: 400). This problem is highlighted by the fact that only one whole hazelnut kernel has been recovered from Mesolithic Scotland, despite the abundance of nutshell. Moreover, hazelnut shells are small, dense and robust and therefore are more likely to fall quickly into the ashes of domestic fires and be carbonised and preserved than lighter seeds and moisture-rich tubers, leaves, seaweed and hazelnut kernels which would more frequently be burnt to ash (Munson et al 1971: 427; Hillman 1981: 140; Minnis 1981: 149; Wilson 1984; Popper 1988: 56; King 1994: 187–8; Carruthers 2000: 411; Mithen 2000: 437; Score & Mithen 2000: 508; Wright 2003: 578; Dark 2004: 2; Pieroni 2005: 29; Anderson 2006: 267). Considering the low chance of edible seed carbonisation, it is probable that seeds were deliberately collected, even when present in low frequencies in archaeobotanical assemblages (Carruthers 2000: 413).

Hazelnut shell is also much more frequently recovered from sites where the only recovery method utilised is hand collection and/or wet/dry sieving with coarse meshes due to its higher visibility, whereas small plant remains are not recovered using such methods (Renfrew 1973: 21; Minnis 1981: 143; Wagner 1988; King 1994: 190; Pearsall 2000: 502). Though flotation was employed on most sites, a notable proportion (31%) of site blocks were derived from hand collected or wet/dry sieved samples (illus 2a). It is important to note that, with the exception of three site blocks that contained less than five non-hazelnut identifications (Morton A, Staosnaig F41/F49 and Carn Southern), seeds, fruit remains and parenchyma/vesicular material/roots/stems were only recovered from the sites where bulk samples had been taken and flotation employed. The small volume of soil processed may also be responsible for the lack of non-hazelnut remains at many sites (illus 2c). Clearly, the larger the sample size, the greater the diversity of species recovered from a site (Jones 1991a: 64), but the extent to which this was a problem is uncertain because the type of sampling strategy employed was only detailed for half of the site blocks (49%). Whilst some assemblages from sites where a total sampling strategy had been employed contained low volumes of plant macrofossils, such as Links House, all the sites with large plant macrofossil assemblages were well sampled: Staosnaig F24, Cramond, Weston Farm and East Barns. This suggests that the dearth of plant remains other than hazelnut shell in the Scottish Mesolithic is partially a consequence of the sampling strategies employed.

FUTURE RESEARCH DIRECTIONS

There is considerable potential to develop understanding of Mesolithic plant exploitation in Scotland. Large Mesolithic plant macrofossil assemblages are extremely scarce in Scotland due to the lack of systematic sampling and flotation of Mesolithic deposits and the small sample sizes usually analysed. The consistent presence of plant remains on most sites, even where no sampling or minimal sampling has been undertaken, suggests that plant remains may be more common on Mesolithic sites in Scotland than has previously been supposed. Since plant remains are typically only present in low densities on Mesolithic sites due to the more temporary nature of occupation and the lower rates of deposition than in later periods, it is essential that future excavations of Mesolithic sites, where possible, float more than the average (*c* 20l) sample size used for later period sites. A potential problem with this suggestion is that sites or features are often only identified as Mesolithic after the material has been sampled and dated (Suddaby 2007: 68; Dunbar 2008: 47; Johnson & Cameron 2012: 17). This is particularly problematic for multi-period developer-funded excavations where there may not be further opportunity to take additional samples or identify additional Mesolithic features through radiocarbon dating. However, in research-driven excavations, there is usually opportunity to return to identified Mesolithic sites and take larger samples of material. For instance, small-scale sampling of an eroding section at the site of Northton, Harris, Western Isles in 2001 recovered a small assemblage of Mesolithic plant macrofossils (Table 3; Gregory et al 2005; Simpson et al 2006). The 100% sampling of a small trench at the site in 2010–11 produced a sizable assemblage of Mesolithic plant remains, which is currently under investigation (Bishop et al 2010; 2011; Bishop 2013). Therefore, of key importance for understanding the nature of Mesolithic subsistence is the routine sampling, analysis and publishing of large archaeobotanical samples from Scottish Mesolithic sites, within an explicit research framework.

Future research should also aim to develop understanding of the types of roots and tubers consumed on Mesolithic sites in Scotland, as these may have formed a key component of the Mesolithic diet. The full identification of suitable parenchyma fragments using an SEM should also be a research priority for any future analysis of Mesolithic plant assemblages in Scotland. In addition, as noted by Hather (2000a), to ensure that more complete parenchyma remains are recovered from Mesolithic assemblages, it is imperative that sub-samples for manual flotation are taken, if large volumes of soil are to be processed using a flotation tank.

CONCLUSION

In conclusion, this review has shown that evidence for plant use was more widespread on Scottish Mesolithic sites than has previously been recognised, suggesting that plants were key resources within Scottish Mesolithic subsistence strategies. Despite the scarcity of plant remains in Scottish Mesolithic assemblages, hazelnut shell was consistently present on most sites. This suggests that, far from being of incidental importance, hazelnuts were a deliberately targeted species, which formed an important component of the Mesolithic diet. Indeed, the discovery of the high-density deposit of hazelnut shells at Staosnaig, Inner Hebrides shows that plants were sometimes processed on a large-scale in the Scottish Mesolithic. Though no burnt hazelnut stores have been identified and hazelnuts were only present in low-moderate frequencies in most assemblages, the presence of hazelnuts on most sites suggests that the plant was routinely and systematically exploited and stored for food because hazelnuts were only available for a limited period in the autumn.

The consumption of the other species discussed is more open to question because other plant remains were extremely rare in the Mesolithic archaeobotanical assemblages reviewed. However, the presence of the carbonised remains of lesser celandine, seaweed, crab apples, hawthorn, vetches/tares and fat-hen in several assemblages, together with the ethnobotanic evidence for the use of these resources, suggests that these plants also formed part of the Scottish Mesolithic diet. Considering the taphonomy of different wild plants and the diversity of plants in hunter-gatherer diets past and present, it is likely that a much greater range of plants was exploited by Scottish Mesolithic hunter-gatherers than has been identified archaeologically. It is also probable that the relatively short duration of occupation of many sites and the limited sampling strategies employed by archaeologists, are responsible for the restricted range and frequency of edible taxa in most assemblages. Further sampling of Mesolithic sites and more detailed analysis of Mesolithic archaeobotanical assemblages is required to fully establish the nature of plant subsistence in the Scottish Mesolithic.

APPENDIX 1: ETHNOGRAPHIC SOURCES CONSULTED

1. Behre 2008
2. Bryant 1783
3. Burrows 2005
4. Cameron 1977
5. Carvalho & Morales 2010
6. Christanell et al 2010
7. Cooper & Johnson 1984
8. Darwin 1996
9. Ebeling 1986
10. Egoumenidou & Michaelides 2000
11. Ertuğ 2000
12. Evelyn 1699
13. Fenton 2000
14. Forsyth 1968
15. Frohne & Pfänder 1984
16. Frohne & Pfänder 2005
17. Gerarde 1597
18. Gilmore 1991
19. Grieve 1992
20. Gunther 1973
21. Hamel & Chiltoskey 1975
22. Hedrick 1919
23. Hill 1941
24. Hogg & Johnson 1864
25. Irving 2009
26. Kuhnlein & Turner 1991
27. Lightfoot 1777
28. Mabey 1997
29. Mabey 2001
30. Marles et al 2000
31. Mears & Hillman 2007
32. Milliken & Bridgewater 2004
33. Moerman 1998
34. Nebel & Heinrich 2010
35. Phillips 1983
36. Pieroni 2010
37. Pierpoint Johnson 1862
38. Ranson 1949
39. Renfrew 1973
40. Stoličná 2000
41. Tardío 2010
42. Tardío et al 2006
43. Vaughan & Geissler 1997
44. Voronina 2000

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